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desires to enter his sons for his own professions or aspires to give them access to the public service of the country. To a matter-of-fact person, the ideal of knowledge for its own sake has few attractions, and his greatest concern is that the money he invests in the education of his children should bring return in the form of enrichment of his own profession, or that their service to the State should be adequately remunerated. Such a man has very little use for the type of education now imparted in our schools and colleges, which in his judgment leads nowhere. One of the criticisms passed on modern education is that the cultural and social advantages of higher education are beyond the reach of the man of humble means. Of all the questions which will engage the earnest and immediate attention of the projected Board, the most important ones appear to us to be the statutory grant, the education of the poor man's children and the problem of the pass-man.

The Government of India contemplate the creation of a number of Committees to assist the Advisory Board in the investigation of relevant problems, and perhaps the most vital question that will confront the Board, when brought into being, must relate to Finance. There should be established a Committee of Finance of moderate dimensions, of independent character and possessed of adequate powers to act as a link between Government and the Board. We would prefer to call this body, Committee of Reference. It should enjoy statutory power for the purpose of elucidating and correlating expenditure on the several grades of education, besides exercising advisory and supervisory authority in connection with the financial allocation in each province. The advice of this Committee in regard to the assignment of contributions by the Central and Provincial Governments to educational and university purposes should be adopted, which would thus secure unification of the financial policies of the different administrative authorities. If such a body is to be efficient it must include independent men of affairs, who could pronounce impartially upon conflicting claims, and also persons who are cognizant of the needs and general practice of the universities and have a genuine interest in their welfare and progress. We emphasise the importance of the Committee of Reference because it is borne in upon us that the clue to the majority of the educational and university problems and the condition of their reforms must ultimately be finance, and unless the Committee secures adequate statutory financial contribution, progress will be impossible.

It is obvious that since the appearance in the political field, many of the social classes in India are anxious to participate in the benefits of higher education, to which they are attracted as an instrument in the task of preparation for their new and arduous responsibilities. They regard higher education as an indispensable equipment for the part that they desire to play in national life. The extension of the franchise, the increasing association with local self-governing bodies and the organisation of social groups have given them power which they rightly think they can exercise for the advantage of their own class and also for that of the nation, if this power is accompanied by knowledge. Our schools and colleges are now filled with the sons of these social classes, because they think that they have a right to share in the national cultural inheritance, and it is appropriate that special facilities and preferential treatment should be offered to them. But in recent times, the discussion of the question of creating special advantages for them has suffered from the defect that little or no attempt has been made to distinguish between the various classes among whom the term "poor" is treated as synonymous with that of "backward". We attribute the failure of some modern educational expedients aiming at reform, to this confusion of ideas, and the fact is that plans suitable to one section have been found almost inapplicable to the other. The changes in the economic life of modern society and in the intellectual progress of the nation necessitates a more scientific distinction of the communities; for the wage-earning classes who could properly have been called "poor" half a century ago have now acquired wealth, while those who may fairly be termed "backward" did not at that time aspire to higher education. But in so far as both of them represent particular strata in the national life, it is obvious that they should have free access to the advantages of higher education.

Perhaps the most delicate and difficult task for the Advisory Board will be to formulate their proposals for the working-class education, to encourage the desire of the industrial communities to profit by

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The Educational Advisory Board.

THE formation of a Central Advisory Board of Education, foreshadowed by Sir G. S. Bajpai at the last session of the Legislative Assembly at Delhi, is, in our opinion, an urgent necessity. In recent times, the academic problem has assumed new and perhaps complex shapes, and in its solution the Government of India might naturally desire to rely on the advice and assistance which this expert body is competent to place at their disposal. When Government abolished the Bureau of Education in 1923, their influence on the formation and execution of the educational policy of provinces practically disappeared and the new Board is obviously intended to restore that influence. It is desirable—means will no doubt be found for it—that the Educational Advisory Board should be so constituted that it will fit into the general framework of Federal Administration, since it is proposed to make it a department of Central Government. Otherwise the experience and progress obtained by the Indian States in the sphere of education will lose contact with the machinery devised for British India. Educational progress in India is hampered by periodic financial inhibitions, and the first task of the Board must be to secure a statutory grant for giving effect to its recommendations.

Among the various factors which have rendered the academic problem increasingly complex in India, mention must be made of the immense expansion of scientific knowledge with its reactions on the social and economic life of the country, the vastly increased demand for higher and technological education, the wider conception of the duties of the modern universities and the emergence in the body politic of social communities which had previously remained indifferent. We are not impressed by the zeal of educationists for the constitutional reform of their institutions, however important they may be to the inner life of their administration, for the outside world always measures the efficiency of the machinery by its results, unmoved by its structural beauty. The problem of the public is comparatively simple. The man in the street

academic discipline. If this desire is genuine, then it seems to us that its satisfaction should not exclusively be left to private enterprise or to a somewhat precarious combination between state and municipal interests, but that it should be recognised and regulated by the Board or by one of its Committees. Should there be a working-men's school and college in every important industrial centre, where education is imparted free of cost? In answering this question, it should be borne in mind that gratuitous benefactions do not promote a sense of self-respect, nor is their value fully appreciated. For the creation of such institutions for the children of humble means, the Board must seek and find assistance from public-spirited benefactors to supplement its other resources. Education is a slow process and naturally therefore it does not excite popular imagination or stir public sympathy. The recent enhancement of school and college fees and dues, owing largely to the shrinkage of grants to these institutions has placed impediments in the way of poor young men who wish to take their share in the academic and social advantages of higher education. If in spite of subsidies in pecuniary or other shapes which the poor disappointed young men might otherwise obtain, there are features in the higher general and professional institutions, which act as a deterrent to the entry of such students. We do not subscribe to the theory that education is meant only for those who have sufficient means and intelligence to profit by it. If a man is sufficiently rich he is often indifferent to education. The purpose of education is to seek those whose intellectual powers are dormant and to stimulate them for the advantage not only of their own class but also for that of the nation. The problem of educating the poor is a national task to which the proposed Advisory Board must give serious attention.

In the way of broadening the avenues for the admission of wider classes to the benefits of higher education, we are met with two problems, *viz.*, examinations and pass-men. If it could be proved that examinations by the qualities that they test, are a valuable adjunct to a young man's education, we might face all the unsparing criticisms which the public heap upon them. Examinations are jumbled together with an uncertain multiplicity of standards with neither consistency nor uniformity. A man who is rejected in one college or university may obtain admission to another where he may pass with honours. This is a question which no scheme of reform undertaken by the Central Advisory Board can overlook, and which cannot be permanently ignored.

The question of examination in the last resort raises the issue of the pass-man and of his position in the field of higher education. We have no concern here with the pass-man whose idleness is responsible for his poor academical achievements but we have every consideration for the other type of pass-man whose honest endeavours have resulted only in very modest performance. It should be remembered before judgment is pronounced on such a student, that he is entirely ignorant of his own mental capabilities. He has inherited these and education cannot replace them, but can only polish them. It is ignorance of this fundamental fact that must account for all the denunciation of these young men and for opinions frankly expressed that the standard of higher education should be sufficiently stiffened to exclude them from its advantages. The Universities have obviously no use for such young men, and the employer passively accepts the verdict of the academic bodies in considering his employability. It seems to us that this judgment is as harsh and hasty, as his rejection is unsound and unwarranted. If the Universities expend their energies and resources on the creation of an intellectual oligarchy, then they cease to be national institutions, and may have to forfeit their claims to be supported by national revenues.

A great injustice is perpetrated when the idle pass-man is taken to be the type of the pass-man in general, and when the sins of the individual are visited upon the class. We shall cheerfully accept the reproach of being Philistine or reactionary, if we can succeed in impressing upon the public mind that the first concern of higher education is to instruct and enlighten the pass-man. If our universities are to continue to deserve public support, they have few more important duties to perform than to give a good general education to the man of poor capabilities. To convert him into an enlightened and useful public servant is as honourable a task of our educational institutions as it is to discover and foster eminent talents, and it is a fact that many of the men, who in later life have reflected the greatest credit on their education, have been those who never took more than a pass degree. We do not believe

in the soundness of the argument that the universities are exclusively for brilliant men, for we do not see any reason why pass and honours men should not exist side by side. We conceive that it is in such co-existence and happy mingling of all talents and social qualities favouring good fellowship and toleration, that the service of the universities to the nation resides.

The Educational Advisory Board when it deals with the question of reforming the educational system in India, will be confronted with the difficult task of framing suitable proposals for educating the poor man and the pass-man, and the task, however difficult, must be satisfactorily solved.

"Science and Culture."

WE have pleasure in offering a warm welcome to *Science and Culture*, a new monthly journal of natural and cultural sciences, the first issue of which has reached us by the courtesy of the editor, and whose aim is to promote the cause of science by spreading scientific knowledge among the public. It is further explained that publication is promoted by a non-profit corporation of "some eminent scientists and educationists of India," whose identity will doubtless be revealed in a subsequent issue.

The subject-matter is varied and interesting. Following an editorial introduction which rapidly sketches outstanding events in the historical development of Indian civilisation, there comes a long and informing article on "Bengal Rivers and their Training" by Dr. N. K. Bose, who wisely advocates establishment of a river physics laboratory resembling those already operating in Western countries, where schemes connected with river-control may be tested before adoption. An article on the "Ultimate Constituents of Matter" by Professor M. N. Saha deals comprehensively and lucidly with modern views of atomic architecture, and concludes with an imposing list of the fundamental particles involved. Rai Bahadur Ramaprasad Chanda, under the title "Aryan, Indo-Aryan and Dravidian" traces the various authorities for different forms of *bhakti*, while "Some Reactionary Consequences of Psychoanalysis" are indicated by Col. Owen Berkeley Hill. A short contribution on "Susruta and Early Hindu Anthropometry", by Dr. Panchanan Mitra is followed—abruptly as it may seem to some readers—by "Safety of Electric Installations in India" from Professor B. C. Chatterjee.

Other features are book reviews, obituary notices, a full description of the Indian Statistical Institute's foundation and purpose, a report of the U.P. Academy of Sciences April meeting, and letters to the editor. Support is given to the view of Lord Rutherford as expressed in his letter to *The Times* dated April 29, 1935, concerning retention of Professor Kapitza by the Soviet Government, and a useful outline of the distinguished captive's technical ingenuity is presented. Treatment of the subject would have gained piquancy—and perhaps proportion—if Lord Rutherford's contribution had been supplemented by the letter of Professor H. E. Armstrong, who considers that the restoration of Professor Kapitza to his homeland, so far from being a calamity, is merely a blessing in fancy dress; but then it must be remembered that this chemical veteran on a recently previous occasion stoutly opposed himself to the principle of imported professors.

From this brief survey it will be recognised that *Science and Culture* covers a wide range of material, and incidentally it may be stated that the printing and paper are excellent. It remains to consider whether the treatment of the subjects chosen is calculated to achieve the declared purpose of the promoters, namely, "dissemination of scientific knowledge amongst the public". A rough classification of the literate public in relation to scientific knowledge would reveal two main groups, namely, specialists in one or more branches, and a generally well-informed public whose members desire to keep themselves aware of such scientific discoveries and principles as may be assimilable without previous training in science. *Nature* and the *Scientific American* are probably the best known journals appealing to these two groups, respectively, and throughout the past three years we have consistently endeavoured to meet the needs of the former group in this country, with strict avoidance of partisan or territorial bias. Some aspects of *Science and Culture* are so similar to the corresponding features of *Current Science* that we confess to misgiving that its promoters have judged us and found us wanting. Actually, there is very little of the material presented in this first issue for which we would not gladly have

found space in our own columns. The question therefore arises in our mind, is there a large enough public for two similar journals ; because, if not, we fear that both must languish, under-nourished in both material and support. On the other hand, there is ample room for a journal popularising science, old and new. Therefore, while welcoming *Science and Culture* we take leave to hope that future issues may devote themselves more definitely to the declared policy of its promoters, and expand on lines complementary to—rather than competitive with—*Current Science.*

Nation Building and Scientific Research.*

EARLY during the Great War, in 1915, His Majesty's Government formed a Committee of the Privy Council for Scientific and Industrial Research, who were entrusted with the task of establishing a close link between science and industry. In the course of the next two years, this organisation developed into the Department of Scientific and Industrial Research under whose auspices a great number of researches of national importance are being carried out. The researches have an intimate bearing on some aspect of national life or industry. The cost of these investigations is being borne by co-operating firms in an ever-increasing measure, thereby showing that industry is appreciating the value of scientific research. The design of ship's hulls, the effect of waves on the resistance and pitching of ships, effect of wind resistances, the behaviour of rudders and the improvement of propellers—all problems connected with the national industry of shipping, are being investigated. The Building Research Station is conducting investigations on the design of steel frame buildings, on methods of increasing the resistance of concrete and mortar to chemical attack, on heating and ventilation problems, on limes, bricks and clays and on cast concrete products—problems closely connected with the life of the nation. The Department has also interested in the development of new high temperature alloys, in discovering new outlets for low grade coals and in the problems of storage and transport of fruits, vegetables, fish and meat, which are of vital importance in securing an adequate supply of wholesome food for the nation. Interesting work seeking an answer to the question "why does one flour from one kind of wheat produce better bread and dough than another ?" is being done by the Flour Millers' Research Association. The National Physical Laboratory is largely concerned with testing and standardisation of products manufactured by industrial concerns. The Leather Research Association, the Paint Research Association, the British Scientific Instrument Research Association, the Food Manufacturers' Association and other Research Associations are all co-operating with the Department of Scientific and Industrial Research in a programme of Nation-building acitvity, to the great advancement and prosperity of the nation as a whole.

M. S.

* Report of the Department of Scientific and Industrial Research for the year 1933-34.

The Artificial Preparation of the Male Sex Hormone.

By Professor L. Ruzicka,

Technical High School of Zurich (Switzerland).

THE male sex hormone may be defined as a chemical compound produced in the testicle, and which in the male organism promotes the growth and function of the sex organs and glands, and also the development and maintenance of the secondary sex characteristics and sex instinct. The discovery of this hormone resulted from successful experiments on castrated male animals, in which the atrophy of the sex characteristics and organs was cured by implantation of the testicles of other adult animals. The first experiments in this direction date as far back as 1849, *i.e.*, long before there existed a science of hormones, when Berthold (Göttingen) successfully implanted fresh testicles into capons.

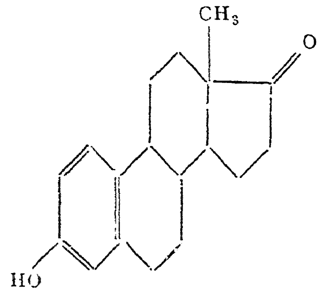
In 1929 Gallagher, Koch and Moore (Chicago) succeeded for the first time in preparing a really effective testicular extract which exhibited, in castrated animals, effects similar to those formerly obtained by grafting fresh testicles. These investigators also worked out the first practical biological test for the detection of the male sex hormone. It is the so-called capon test, which was subsequently improved by Funk, Laqueur and others, and which is based on the principle that the stunted comb of a capon increases in size by the injection of the male sex hormone, such increase being roughly proportional to the quantity of hormone injected. We call a capon unit the quantity of hormone which, with a definite technique, produces an increase of about 20% in the surface area of the comb.

With the help of this method, Butenandt (Göttingen) isolated in 1931 a male sex hormone in crystalline form from the urine of men; the injection into a capon of 0·3 to 0·4 milligrammes of the said hormone, in fractional doses, in the course of a few days produces a 20% increase in the surface area of the comb. The isolation of this hormone, called androsteron, is extremely laborious and up to the beginning of 1933 only 25 mg. of it had been isolated, for which quantity 50,000 litres of urine were required. Butenandt was able to establish that androsteron is a saturated oxyketone having the formula $C_{19}H_{30}O_2$ or $C_{19}H_{28}O_2$, and possessing four rings, although an exact chemical investigation was not possible at that time owing to the difficulty of obtaining sufficient quantities of the hormone. It was, however, possible to form a hypothetical picture of the probable structural formula of androsteron on the basis of the knowledge of the follicular hormone (theelin, œstrin) acquired in the meantime.

Following the discovery in 1923 of Allen and Doisy's test for the ovarian hormone, Butenandt and Doisy succeeded, independently and almost simultaneously in 1929, in isolating theelin in a crystalline form from the urine of pregnant women.

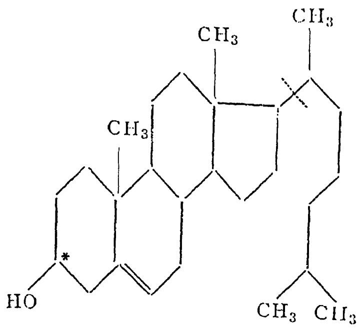
The chemical investigation of this substance by Doisy, Butenandt, Marrian and Cook, led to the assignment of formula I.

The simple manner in which this formula can be derived from cholesterol supports its correctness.



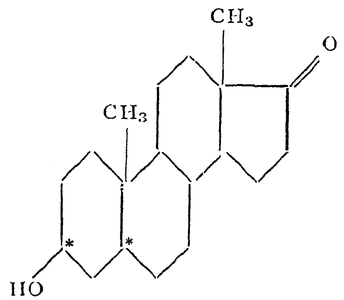
I

Theelin

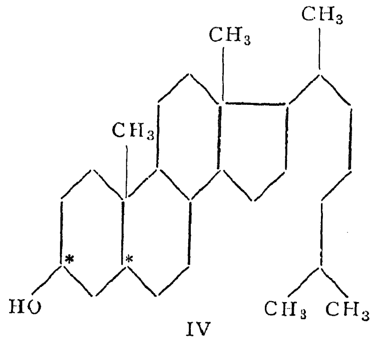


II

Cholesterol



III
Androsteron



IV
Dihydrocholesterol and stereoisomeric sterols

It is only necessary to consider that the terminal six ring of cholesterol is dehydrogenated with the formation of a phenol ring, and further, that the long side-chain is completely split off by oxidation with the formation of a ketone group.

Assuming that androsteron is also derived from cholesterol, the formula $C_{19}H_{30}O_2$ leads to the structural formula III which Butenandt proposed in 1933, as an intermediate product in the course of the hypothetical conversion of a hydrogenated sterol into theelin. The formation of a substance corresponding to formula III from hydrogenated sterol, requires only the splitting off of the long side-chain, in the same way as theelin is considered to be formed in the body by the oxidative degradation of a dehydrogenated sterol.

In view of the great difficulties which were to be expected in an attempt to determine the exact constitution of androsteron by entirely analytical methods, the author, together with his assistants, M. W. Goldberg, Jules Meyer, H. Brüngger and E. Eichenberger, decided to approach the question from another angle. An attempt was made to prepare the hormone artificially by following as closely as possible the method which nature probably uses for producing it in the body.

It was first of all necessary to investigate the question of the most suitable material to be used for the proposed work. We have discussed above the hypothesis of the derivation of theelin from cholesterol. However, up to now there are no facts at all showing that theelin is stereochemically identical with cholesterol. Further, in the artificial preparation of androsteron it was necessary to take into consideration the steric structure at the two positions marked with an asterisk in formula III. All hydrogenated sterols hitherto known differ one from another by a different steric position at these two carbon atoms. Four different stereo-isomers of the formula IV are known: dihydrocholesterol, epi-dihydrocholesterol, koprosterol and epi-koprosterol. We have included all these stereo-isomers in our investigations. Before the splitting off of the side chain, the hydroxyl groups were protected by acetylation from the action of the chromic acid used as the oxidising agent. It must be emphasised, that according to the statements in the literature, it was very improbable that a ketone of the type of androsteron could result from the oxidation of an acetylated sterol corresponding to formula IV. This improbability has certainly deterred, up to now, other investigators from employing this exceedingly simple method for the solution of the problem of the male sex hormone. However, our optimism proved to be justified. By oxidation of the acetates of the 4 sterols named, we were able to isolate the corresponding 4 oxyketones. The oxyketone derived from epi-dihydrocholesterol proved to be identical in every respect, chemically, physically and physiologically, with the natural androsteron. On the other hand, the other three isomers are distinctly different from androsteron.

Although there was from the beginning a certain probability that androsteron might belong to the sterol group, no one could have expected that it was derived from epi-dihydrocholesterol. Girard, for instance, had considered the hypothesis of lithocholic acid being the mother-substance from which androsteron originates, while Butenandt thought koprosterol more feasible. No one had previously imagined the existence of a derivative of epi-dihydrocholesterol (or of epikoprosterol) in nature.

A comparison of the physiological action of the 4 stereo-isomeric oxyketones $C_{19}H_{30}O_2$ shows the importance of the steric

configuration for the hormone character. Whereas with androsteron (both natural and artificial) a capon unit amounts to 0·07 mg., one injection a day being made during six consecutive days, one unit of the oxyketone derived from di-hydrocholesterol is 0·5 mg. The two oxyketones derived from koprosterol and its epimer were ineffective in daily doses of 1 mg.

The synthetic preparation of androsteron permitted for the first time the complete elucidation of the constitution of a sex hormone. This is a rare case of the elucidation of the constitution of a natural product of intricate composition, by the artificial preparation of the substance before anything was known about the structure of the carbon skeleton.

In this case the method of elucidation was just the reverse of that usually employed: the first detailed publication of Butenandt on the chemical reactions of androsteron which appeared two months after our communication of the synthetic preparation contains no mention of a degradation product of androsteron which might have been identified with a compound of a known constitution.

The greater accessibility of synthetic androsteron permits the investigation of the question of whether there is only one male sex hormone, or if several compounds together are responsible for the effects observed. Butenandt has already discovered a second male hormone in the urine, dehydro-androsteron, which acts in the same manner as androsteron on the capon's comb, but is distinctly weaker. There are also several female sex hormones all of which, however, exhibit a weaker action than theelin. According to our present knowledge, theelin suffices for the production of the effects of the ovarian hormone. The results obtained up to now with androsteron do not contradict the assumption that it can exhibit all the effects which one expects from the testicular hormone. Let us now describe briefly the most important physiological investigations, which have been carried out by E. Tschopp in the "Ciba" Laboratories in Basle.

The capon test shows that an overdose of androsteron causes an exceedingly pronounced increase in the size of the comb. For example, by painting the comb (according to Fussgänger's technique) daily for ten days with a $1^0/_{00}$ solution of androsteron we observed that the surface of the comb was increased sevenfold.

Furthermore, painting with a $0·5\ ^0/_{00}$ solution of androsteron, the site where later the comb grows on newly hatched chickens........causes, after a few weeks, the appearance of a comb of approximately the same size as that of cocks having attained their full development.

From a clinical point of view, it is interesting to note that with capons in which too small a portion of testicle has been preserved for the stunted comb to be able to grow, temporary injections of androsteron cause a prolonged growth of the comb. In completely castrated capons, on the contrary, the comb stops growing on cessation of androsteron treatment, whereupon a gradual atrophy of the comb to its initial size takes place. Such effects have already been observed following the administration of testicular extracts. In certain cases of testicular hypofunction, androsteron can act as a "hormone fillip" to stimulate the inactive generative glands into new activity. Investigations with mammals in that connection will be of great importance.

Furthermore, in castrated male rats, it was possible to obtain with androsteron a complete cytologic regeneration of the atrophied seminal vesicles (positive test according to Lœwe-Voss). Finally the "wedding dress" picture of the male small fish called *Rhodeus amarus*, which is obtainable with testicular extracts, could also be produced with androsteron. All the experiments which have been carried out in the past with the various extracts exhibiting the action of the male sex hormone, and especially with testicular extracts, will be repeated with synthetic androsteron, which will subsequently also be tested clinically. These experiments will show whether androsteron, or any of its derivatives possessing stronger physiological properties, can completely play the rôle of the male sex hormone.

Locust Research Work in India.

By Rao Sahib Y. Ramachandra Rao, M.A., F.R.E.S.,
Locust Research Entomologist to the Imperial Council of Agricultural Research, Karachi.

I. Introductory.

DURING the last decade, locusts have, in many parts of the world, been so much in the limelight that they hardly stand in need of introduction. During the years 1929 and 1930 especially, there were not many days on which mention was not made of them in the Indian Dailies, either in regard to their flights or the damage done by them to crops. Nor are locusts to be counted as one of the recent upheavals of the modern age. Their history apparently dates back to hoary antiquity. They are mentioned in the Bible, and formed one of the plagues of ancient Egypt. In early Sanskrit literature, references are made to them as one of the recognised calamities of the people. The immensity of the swarms, whose countless myriads often form clouds hiding the sun from the face of the earth, the dramatic suddenness of their appearance, and the terrible severity of their onslaughts, have all combined to infuse a feeling of helplessness and awe in the mind of primitive man, with the result that incursions of locusts have from time immemorial been considered to be of the nature of an act of God. Indeed, the Indian cultivator, be he Moslem or Hindu, often expresses himself unwilling to lift his hand against these pests, ruinous though they may be to his food-crops, as he believes the visitation to be a manifestation of Divine Wrath, which he dare not resist.

II. India's Locusts.

Few people are unfamiliar with grasshoppers, which may be found jumping about on the surface of lawns and fields. Locusts differ very little from them either in their general form, structure or habits, except for the fact that they often occur in large communities, which move about from place to place in gregarious swarms. There are several different species of locusts in the world, each of which has its own more or less restricted area of distribution. Not taking into account half a dozen species of Indian grasshoppers, which are known to increase in numbers periodically and cause immense damage to crops, there are only three species of true locusts in India, of which one, *Locusta migratoria*, though occurring widespread over the length and breadth of this country in its solitary phase, has, for some hitherto unaccountable reason, been very rarely recorded in its swarming condition. The other two, *viz.*, *Patanga succincta*, L.—the Bombay Locust,—and *Schistocerca gregaria*, Forsk.—the Desert Locust,—have in the past appeared in enormous swarms over large areas of India and caused a great deal of destruction to agricultural crops. Of the two, the Bombay Locust affects mostly the peninsular region of India. From the information available, mainly Lefroy's account in his *Memoir* on the Bombay Locust, this locust would appear normally to be a denizen of the forest areas of the Western Ghat ranges of the Bombay Presidency, whose flights may spread in years of heavy multiplication far and wide, as far as Guzerat to the north, as far as Central India and Hyderabad, and even Bihar and Orissa in some years, to the east, as far as Madras Deccan to the south, and upto Ratnagiri and Goa to the west. On the other hand, the Desert Locust is, *par excellence*, the Locust of North-West India. During years of outbreak, it infests chiefly Baluchistan, Sind, Punjab, the North-West Frontier, Rajputana, United Provinces and parts of Central India, but in years of extraordinary activity its flights may reach as far as east Assam and as far south as Madras Deccan. The Desert Locust is by far the more important of the two, for, the range of its spread is much wider, the periods of its outbreak are more frequent and prolonged, and the extent and degree of damage to crops is on the whole much greater. The scheme of Locust Research carried on under the auspices of the Imperial Council of Agricultural Research is concerned at present only with the Desert Locust.

III. The Origin and Scope of the Present Scheme.

Although locust outbreaks have been fairly frequent in the past, and have often been serious enough to engage the attention of a huge staff and lead to the expenditure of large sums of money in connection with control work in a great many districts of North-West India, it is surprising how little had been recorded about the central facts of its life. There were but vague and

indefinite notions as to wherefrom the swarms originated or how they responded to changes in the environment. Except for the excellent account given by E. C. Cotes in his Report on "the Locust of North-West India", 1890, no comprehensive survey of the movements of locusts in India had been made during the various locust cycles of the past. The reasons for this are not far to seek. The incursions of locusts are periodic and even during outbreaks, their appearance is definitely seasonal in most places. While they are aggressively evident during times of invasions, and while the Government as well as the public are feverishly active with the carrying out of control measures against them, sooner or later they disappear from the areas of infestation, and before long they become a mere memory. People feel relieved at their non-appearance, and take no further interest in them till they are back once again menacing agriculture.

The provincial entomologist, who is naturally occupied with and interested in the pests of his own province, attends to a study of locusts and to their control while they are active within the limits of his province, but cannot of course be expected to continue his researches when they have retreated beyond the limits of his jurisdiction. On the other hand, in the desert regions of Baluchistan and Rajputana, where the locust appears to linger on during the periods of its non-activity, no entomological staff is existent to study the question. This would appear to be the main reason why so little is known of the life-economy of the Desert Locust and why the problem has been so little investigated. In the case of a pest of this description whose distribution is not confined to a single province or country and whose powers of spread by direct flight are so enormous, a proper study of its life-habits or migration can obviously be undertaken by an organisation working under the ægis of a Central Government.

After a long period of quiescence lasting over six years, the Desert Locust appeared all of a sudden in Sind and Rajputana in August–September, 1926 and bred in enormous numbers. thereby starting the last great cycle of 1926–1931. The peak of the attack was reached in the years 1929–30, when almost all the provinces of North-West India were infested and the resulting swarms reached eastwards as far as Assam and southwards as far as Hyderabad (Deccan). It was in the thick of the against this formidable outbreak of pest in the rich agricultural areas of Pu United Provinces and Sind, that the Gov ments of the various provinces of Nort India realised what serious proportions locust menace could assume and how perfect the existent knowledge of the lo problem in India was. As a result question was included in the agenda of Board of Agriculture in India, which at Pusa in December, 1929. After discussion, resolutions were passed at meeting recommending (1) the forma of a Locust Bureau under the auspice the Imperial Council of Agricultural search for the prompt collection, colla and distribution of locust intelligence wi Indian limits, (2) the institution of a Lo Research Scheme in India for conduc research in regard to control methods, locating the permanent breeding grou and the migration routes of the locus India, and for working out its bionon thoroughly, and (3) the organisation control methods on efficient and co-ordin lines in all the affected states and provi including the central storage of anti-lo material by the Central Government.

Action was taken by the Governmen all these recommendations in due co The Central Locust Bureau of the Imp Council of Agricultural Research bega function early in February, 1930 and been of great service in giving pro warnings to areas subject to infestation regard to the activities of locusts. Entomologist—Rai Sahib G. R. Dutt, B. was also attached to the Central Bu from May 1930 to March 1932. Arra ments were also made for the storage some anti-locust material at Delhi.

Last but not least, a Locust Rese Scheme financed by the Imperial Co of Agricultural Research began to func from December, 1930 under the charge M. Afzal Husain, Esq., M.A. (Cantab.), M I.A.S., Entomologist to the Governmen Punjab, as Locust Research Entomolo to the Imperial Council of Agricult Research with head-quarters at Lyallp Through the kind permission of the Pu Department of Agriculture, the Lo Research Scheme had the benefit of all facilities of the up-to-date laboratories of Entomological Section at Lyallpore, various problems connected with the history and bionomics of the locust

worked out during the years 1931, 1932 and 1933, by specially appointed staff under the direct guidance of Mr. Afzal Husain. Much difficulty was, however, felt during 1932 and 1933 in obtaining live material for experimentation owing to the disappearance of locust swarms by the end of 1931.

In regard to the location of the locust breeding grounds, a special touring staff was recruited in January 1931 for carrying out locust surveys of the desert areas in Baluchistan, Sind and Rajputana, and placed under the writer, as Deputy Locust Research Entomologist to the Council, with headquarters at Quetta. As specimens of the solitary phase of the locust were discovered by the staff during the tours conducted in 1931 in the coastal areas of Mekran, a special Field Research Station was established at Pasni in the midst of typical locust breeding grounds in January 1932 and placed under the charge of Dr. K. R. Karandikar as Assistant Locust Research Entomologist for studying the ecology of the solitary phase locust in its natural habitat.

Since April, 1933 Mr. Afzal Husain's services were required by the Punjab Agricultural Department for the Principalship of the Punjab Agricultural College. He could not, therefore, continue to be in charge of the Locust Scheme, but undertook to continue his work on bionomics at Lyallpore, with the help of a research grant from the Imperial Council of Agricultural Research and the responsibilities of the charge of the rest of the Scheme devolved on the writer from that date.

IV. PROGRESS MADE IN THE LOCUST INVESTIGATION WORK.

Locust research has been in progress for over four years at the moment of writing, and it may be stated without exaggeration that quite a large amount of work has been accomplished. It may also be mentioned that the work done every year has been scrutinised by the Locust Advisory Committee of the Imperial Council and has had, therefore, the advantage of their approval and advice in most particulars. The progress made may be dealt with under the following heads:—

1. *Survey Work.*—In 1931 survey work was mostly confined to Baluchistan where most of the districts subject to locust infestation were examined, especially Mekran, Kharan, Lasbela and Chagai. A part of the Bahawalpore desert area was also examined. In 1932, survey staff was reorganised, and work was pushed on by means of a motor-lorry purchased by the Imperial Council for touring purposes, and various centres in the Indus Valley of Sind, parts of Baluchistan, and the Dera Ghazikhan District, and parts of Bahawalpore, Bikaner, Jodhpur, Cutch and Western India States were visited. Wherever roads were non-existent, as in the interior of the Indian Desert, tours were carried out on camel-back. In this manner, quite a number of places were located in which locusts of a non-gregarious character were noticeable. During 1933, the plan of survey work was changed. The work was confined to the areas where locusts of a non-migratory type had been located, and the places were visited periodically throughout the year in order to note the effect of the seasons on the activities of the solitary locusts. In 1934, the same plan was pursued, but with the addition of two Desert Observation posts where intensive observations on locusts were to be carried out in addition to the recording of certain simple bioclimatic data.

Results of Survey Work.—While locust swarms easily attract regular attention and their movements may be expected to be reported by existing official organisations, the existence of locusts in their non-gregarious form is apt to be missed altogether unless specially trained staff is employed to look for them in their natural habitat. Owing to the enormous extent and the comparative inaccessibility of the area to be examined, and the sparsity of the locust population, it would be rather futile to expect a high degree of thoroughness from the small staff employed. The results actually obtained have, however, been sufficient to indicate that, in certain cases, specimens of locusts of what looked like the solitary type were either the remnants of the swarms of 1931 or their descendants. It was also noticed that at present locusts are either entirely absent or are very sparse in many of the places where they were found abundantly in 1932. The observations made have also shown that as in the case of the migratory type, the non-gregarious type of locust is dependent on rainfall for oviposition and breeding, and there appears to be some evidence to show that, like the migratory phase, the non-gregarious type is capable of making migrations over short distances though only as individuals. On the whole, it would rather look as if locusts were gradually disappearing from the areas

of the Indian Desert, and the present situation rather indicates that the 'rek' areas of the Mekran Coast are possibly more important from the locust-breeding point of view.

In addition to making observations on locusts the staff engaged on survey work have also as far as possible attended to the collection of the flora and the fauna of the tracts examined.

2. *Bionomics.*—The various known facts of the life-history and the habits of the locust are ultimately referable to the fundamental peculiarities of its structure and to the nature of its response to the impact of its environment. An exact knowledge of the nature and extent of the responses exhibited by the locust can only be obtained by an experimental study conducted under clearly defined conditions; and the results of studies would be valuable, not only for offering an explanation in regard to the activities of locusts under natural conditions, but also for devising efficient control measures. Valuable work on these lines has been done at Lyallpore in regard to various points in the life-history of the locust, *viz.*, pairing, oviposition, post-embryonic development, effect of crowding and other conditions on the colouration, etc., of hoppers, number of broods in the year, the effect of various tropisms, etc. The results of these studies are now under publication by Mr. Afzal Husain.

3. *Ecological Work.*—Most of the work on the life-history and habits of the locust published in the past is referable to the gregarious phase of its existence, and very little is on record in regard to its solitary phase. Since the areas around Pasni are apparently some of the true breeding grounds of the Desert Locust, the data collected during the last three years, in regard to the behaviour of the solitary locust in response to fluctuations of environmental conditions incident to seasonal changes, should doubtless be of great value. The central problem of these ecological studies in the elucidation of the conditions under the influence of which the change of phase—*viz.*, from solitary to the gregarious—would occur in nature. From the Locust Research point of view, the importance of a breeding ground would depend on how far conditions favouring the building up of the initial swarms of an outbreak are present, in which case alone it would function as an outbreak centre.

From the experience gained so far, it is evident that seasonal rainfall is by far the most important factor in the life-economy of the solitary phase locust. Breeding can take place only if there is rainfall, and a building up of the population would become possible only if an acceleration of breeding and a rapid succession of generations are brought about by the persistence of the requisite favourable conditions of weather.

4. *Study of Past Outbreaks.*—The memory of the serious locust infestation which lasted for nearly six years from 1926 to 1931 is possibly still fresh in the minds of most people in North-West India. This cycle was preceded by a period of about six years, roughly from 1920 to 1925, in which there was no general infestation, and we are apparently now in a similar non-locust period which began from 1932 and has already lasted over three years at the present moment. From the data at present available it is difficult to say when this period would end and the next locust cycle would commence. In this connection, a study of the past invasions is of great importance and all attempts have been made to secure reliable data on the subject. It has, however, to be stated that past records on locusts have in most cases not been preserved, and the information obtainable in such as are existent is very fragmentary in character. In certain exceptionable cases, however, as in that of the season and crop reports published in the Gazettes of Punjab, Sind and Bombay, fairly detailed and continuous information is available from the year 1869, and these have been extracted, collated and studied. In certain other instances also, *e.g.*, the records of the Jaisalmer and Kalat States, detailed information was obtainable in regard to some years. A study of the old records has shown that there have been locust cycles during the following years since 1869: 1869 to 1881, 1889 to 1907, 1912 to 1919 and 1926 to 1931, the intervals being periods of locust disappearance. During years of outbreaks, it would appear that swarms are, during the earlier months of the year, active mostly in areas of winter and spring rainfall, such as Baluchistan and parts of the Punjab, Afghanistan and Persia, and lay eggs and breed there. The adult locusts produced by these broods would appear to commence their flights during the months of April, May and June, the general direction being eastwards towards Sind, Punjab and Rajputana, where

they breed after the receipt of monsoon rains. The resultant fliers would appear to fly during the autumn months, partly further east towards Bengal and Assam or to the south, and partly back to the west towards Baluchistan and Persia. The east-bound flights appear ultimately to perish while the west-bound ones are able to breed during the spring months in Baluchistan. It would also appear that the infestation is prolonged if this circulatory system of locust flight is kept up, and that the break-down of the cycle is probably brought about by the failure of broods due to unfavourable conditions of weather in one or other of the breeding areas.

The data collected from the various files have been extracted and arranged and are being mapped out month by month for the various years, and attempts are being made to correlate the movements with available meteorological data.

V. PRESENT POSITION OF THE WORK.

Much ground has already been covered, but there is yet much work to be done.

In regard to bionomics, progress of work has been impeded mostly for want of material for experimentation, and experiments will be resumed when there is sufficiency of material. The question of sex-maturation of the locust is specially important and needs being tackled. Experiments in regard to control measures will also be undertaken when sufficient material is available.

As to survey work, it is necessary that work should be continued until a decisive answer is obtainable to the question as to which of the areas in which the locust has been found in the non-gregarious state are really important in the production of swarms. It is also necessary to determine the exact conditions under which the transformation into the gregarious phase would take place in nature. In case it is definitely proved that there are outbreak centres within Indian limits, it would be imperative to undertake a trial of control measures on the breeding grounds to determine the best methods of tackling the pest in an early stage and thus nip the evil in the bud. When the migration routes followed by swarms during periods of infestation in India have been properly studied and plotted out, it ought to be possible to formulate a system of timely locust warnings, to neighbouring provinces or countries on the basis of such studies.

Gaps in Our Knowledge of the Indian Protozoa. I.—Ciliophora.

By B. L. Bhatia, D.Sc.

DURING the last four years, while preparing a volume on Ciliophora for the Fauna of British India, I have become aware of various gaps in our knowledge of these Protozoa. Although many more genera and species are now known from this subcontinent than was the case in 1916 when I first directed my attention to this group, there is still a vast and promising field for future workers to cultivate. The Ciliophora are a sub-phylum of the Protozoa, and include forms which live in water, soil, or as parasites of other animals. It is well known that species of fresh-water and soil protozoa are cosmopolitan. The record of Ciliophora known from India, Burma, and Ceylon now includes 274 species belonging to 101 genera. The majority of these are from fresh-water or from the soil. Most of them are the same as found in Europe or America, and there is every likelihood of those described as new, being found in other parts of the world also. This is due to the fact that the conditions of life in pools and ponds are much the same all over the world, and the fresh-water forms can be easily carried from one place to another, especially in the encysted form, by wind and animals. Unlike the fresh-water protozoa, the geographical distribution of parasites usually follows that of their hosts. Some parasites are unable to live in any other host than the one in which they naturally occur and show a host-parasite specificity, though, not unoften, the hosts living in the same habitat may adopt each other's parasites.

The Ciliophora are divided into two classes, *viz.*, CILIATA and SUCTORIA. Following Metcalf, the Opalinid ciliates which do not show a differentiation of the nuclear material into a macronucleus and a micronucleus, have been separated into a subclass and designated as PROTOCILIATA, the rest of the Ciliata which show this nuclear differentiation being called the EUCILIATA.

The Protociliata include a single family *Opalinidæ* which were formerly lumped with other Astomatous ciliates. They are clearly

'an offshoot from the primitive Ciliata before the latter had acquired true binuclearity and the subsequent dimorphism of nuclei'. Metcalf has divided the family into sub-families, PROTOOPALINÆ and OPALININÆ according as the number of nuclei is two or many. The former are not representated in India, and both genera of the latter, *viz.*, *Cepedea* and *Opalina* are known by 8 species of each from various frogs and toads. An examination of Anuran hosts other than those examined already is sure to reveal the existence of many new species. There are many problems about the morphology and physiology of the opalinids which also require further study. The cytoplasmic inclusions, the neuromotor complex as revealed by silver nitrate impregnation and exposure to light, the structure of the nuclei, the nuclear changes during life-history, the causes of the relatively greater abundance of these parasites in the tadpoles than in the adult, are some of the problems well worth further investigation.

The EUCILIATA are divided into 4 orders, *viz.*, HOLOTRICHA, SPIROTRICHA, PERITRICHA and CHONOTRICHA. In the Holotricha the cilia are uniformly distributed over the body in longitudinal rows or limited to particular areas. They comprise the sub-orders GYMNOSTOMATA, TRICHOSTOMATA, HYMENOSTOMATA and ASTOMATA.

All the sub-orders of Holotricha are well represented in India. The Gymnostomata are represented by such well-known genera as *Holophrya*, *Urotricha*, *Prorodon*, *Lacrymaria*, *Enchelis*, *Didinium*, *Coleps*, *Spathidium*, *Bütschlia*, *Litonotus*, *Loxophyllum*, *Dileptus*, *Loxodes*, *Nassula*, *Chilodonella*, etc. *Bütschlia parva* has been recorded from the stomach contents of the ox, and *Chilodonella rhesus* from the intestine of the common Bengal monkey. No representatives have so far been found of the families ACTINOBOLIDÆ, METACYSTIDÆ, DYSTERIDÆ, PYNCNOTHRICHIDÆ and FŒTTINGERIDÆ.

The Trichostomata are classified into 9 families of fresh-water genera, and 4 families of parasitic genera. The fresh-water Trichostomata are represented by species belonging to *Plagiopyla*, *Colpoda*, *Paramecium*, *Drepanomonas* and *Opisthostomum* and the parasitic ones by *Isotricha prostomum* and *Dasytricha ruminantium* from the stomach of ox, and *Charonella ventriculi* from the stomach of the mouse-deer, and three species of *Conchophthirius* which are commensals in the mantle chamber of *Lamellidens*. There are no records of the families SCIADOSTOMIDÆ, SPIROZONIDÆ, TRICHOSPIRIDÆ, CLATHROSTOMIDÆ, MARYNIDÆ and CYATHODINIIDÆ.

The Hymenostomata are represented by species belonging to *Frontonia*, *Sigmostomum*, *Trichoda*, *Glaucoma*, *Colpidium*, *Pseudoglancoma*, *Stegochilum*, *Uronema*, *Ophryoglena*, *Cyclidium*, *Pleuronema*, *Balantiophorus*, *Urocentrum* and *Telotrichidium*. The families PHILASTERIDÆ, LEMBIDÆ, ANCISTRUMIDAE, and HYPOCOMIDÆ are not represented.

The Astomata are divided into 11 families of which the family ANOPLOPHRYIDÆ only is represented by 5 species of *Anoplophrya* and 1 species of *Maupasella*. The family HAPTOPHRYDÆ is doubtfully represented by two species of *Caudalina*, a genus inadequately characterised by Madhava Rao.

The Order SPIROTRICHA is characterised by the peristome possessing an adoral zone of cilia arranged in a left-handed spiral, leading to the cytostome. They comprise the sub-orders HETEROTRICHA, OLIGOTRICHA, ENTODINIOMORPHA, CTENOSTOMATA and HYPOTRICHA.

The Heterotricha are represented by species belonging to the well-known fresh-water genera like *Spirostomum*, *Stentor*, *Folliculina* and *Bursaria*, and equally well-known parasitic genera *Nyctotherus* and *Balantidium*. Nine species of *Nyctotherus* and sixteen species of *Balantidium* have been described from India and Ceylon. The families METOPIDÆ and LICNOPHORIDÆ are however not represented.

The Oligotricha are represented by species of *Halteria*, *Codonella* and *Tintinnopsis*, but the family STROBILIDIIDÆ is not represented.

The Entodiniomorpha including the parasitic genus *Entodinium* and other related genera has been exhaustively studied in a series of three monographs, by Kofoid and Mac Lennan on material collected some years previously at Coonoor and Colombo from the stomach of the ox. The original genera of the Ophryoscolecidæ, *Entodinium*, *Diplodinium* and *Ophryoscolex*, have been split up, and variously shuffled and recombined by various authors. As many as 10 genera and 43 species are recognised by Kofoid and Mac Lennan as occurring in the contents of the stomach of the ox, and species from the stomach of the mouse-deer. The family CYCLOPOSTHIIDÆ is not represented.

The sub-order Ctenostomata recently constituted by Kahl for including the families Epalcidæ, Mylestomidæ and Discomorphidæ, is altogether unrepresented in India, so far as our present knowledge goes. The Hypotricha have not been adequately studied, but still representatives have been recorded of all the principal families. Species of the genera *Peritromoides*, *Urostyla*, *Holosticha*, *Uroleptus*, *Pleurotricha*, *Gastrostyla*, *Gonostomum*, *Oxytricha*, *Balladinopsis*, *Euplotes*, *Aspidisca*, *Aspidiscopsis* have been recorded from different parts of the country.

In the order PERITRICHA are included cone-shaped or bell-shaped organisms, usually attached to various objects by a stalk arising from the dorsal surface. The stalk is frequently retractile like a spiral spring or is divided into a branching system. In the adult organism, the cilia are present only on the ventral surface which forms the vase of the cone. The adoral cilia are arranged in a right-handed spiral. The adoral row of cilia (in some forms two parallel rows), commences at a point on the ventral surface, and follows a course like that of a flat watch-spring till its outer end passes into a cone-shaped depression (or vestibulum), within which lies the cytostome leading to the cytopharynx. The cilia may be continued into the pharynx as such or may fuse to form an undulating membrane. Species of the genera *Scyphidia*, *Vorticella*, *Carchesium*, *Epistylis*, *Cothurina* and *Vaginicola* are known, but representatives of the family Urceolaridæ which includes such ectoparasites as *Urceolaria* and *Trichodina* have not been met with.

The order CHONOTRICHA has been constituted for a small group of forms formerly included in the Peritricha. The peristome is developed as a hyaline, spirally convolute, membranous funnel, one limb of which descends into an oral funnel. The order includes ectoparasites or commensals of crustacea and other aquatic creatures. No one has studied these forms in India so far.

The class SUCTORIA has been almost completely neglected in India. Only a very few species belonging to the genera *Tokophrya*, *Acineta*, *Podophrya* and *Sphærophrya* have been noted. No representative is known of 5 families out of 7 into which the group is divided. Some one should take up the study of this group, in order to make our records of the Protozoan fauna somewhat fuller.

We will now briefly survey some of the major groups of the animal kingdom and indicate from what particular hosts the parasitic ciliates have been studied, and from what others it should be possible to obtain suitable material. There are records of *Balantidium coli* from man, from Calcutta and Lahore but so far as we are aware not from any other part of the country. Cattle, sheep, goats, pigs and horses are our most useful domestic mammals. The rumen (paunch) and reticulum (honeycomb) of the ruminant stomach are œsophageal derivatives and as such contain no glands to secrete either acid or ferments. The contents consist of water and large quantities of saliva mixed with the partially triturated food of the animal, which consists of succulent or dried green plants and grain. The fluid serves as an ideal medium for the growth and multiplication of ciliates, flagellates, amœbæ and bacteria, and there is a Protozoan fauna more or less specific to the ruminants. Buisson (1923), Becker and Talbot (1927) and Dogiel (1927) have published useful work on the intestinal parasites of mammals. Till 1927, according to Dogiel, 65 species and varieties of Ophryoscolecidæ had been found in cattle, 32 in sheep and 19 in goats. As noted above, thanks to the labours of Kofoid and Mac Lennan (1930–33), no less than 43 species belonging to as many as 10 genera are now known from the stomach of the Indian ox (*Bos indicus*) from Coonoor and Colombo.

Jameson has described *Charonella ventriculi* from the cattle, and *Entodinium ovalis* from the mouse-deer from Ceylon. Cooper and Gulati (1926) described *Balantidium coli* var. *bovis* from the cattle. Apart from these interesting records, no one seems to have recorded or described any ciliate parasites from the sheep, goats, pigs or horses. E. Ghosh (1929) described what he regarded as new species of *Balantidium* and of *Chilodonella* from the monkey.

Ciliates are not generally found to occur in the alimentary canals of birds, reptiles or fishes, though one species each of *Balantidium* is known from a bird, a tortoise and a fish from other parts of the world. Frogs and toads are commonly infected with Opalinids, *Balantidium* and *Nyctotherus*. Eleven species of frogs and toads have been studied for their parasites and 17 species of Opalinids, 7 species of *Nyctotherus*, and 10 of *Balantidium* are known from them. Dobell (working in Ceylon in 1910), Ghosh and recently H. Ray in Calcutta, de Mello in Nova Goa, and

Bhatia and Gulati in the Punjab have contributed to our knowledge of these parasites.

Parasites and commensals from Mollusca include a species of *Nyctotherus*, a species of *Balantidium*, 3 species of *Conchopthirius*, and 3 species of *Anoplophrya*. Species of *Nyctotherus* and *Balantidium* are also known from the Cockroach and certain other Arthropods. Species of *Anoplophrya* and *Maupasella* are known from the fresh-water Oligochæte *Aelosoma* and from 2 species of the earthworm *Pheretima*. And lastly, Protozoa are known to parasitize other Protozoa, and a suctorian *Sphærophrya* sp. has been recorded from *Paramecium caudatum*.

Some of the ciliate parasites are very interesting from the morphological point of view. The holotrichan *Ichthyopthirius multifilus* which is parasitic in the skin of fish, the various ciliates which occur in the cæcum of the horse; *Trichodina* which slowly creeps over the external surface of *Hydra* and is also found on the skin of fish; *Spirochona* known to occur on the gills of fresh-water crustacea, and *Licnophora* which is an ectoparasite of various marine animals, should all be looked for by those who have an opportunity to do so, and will very likely be found.

In conclusion, we will say a few words about the regional distribution of the ciliates that have been recorded so far from various parts of India. Following the regional divisions of India as adopted by Stephenson in his volume on Oligochæta in the fauna of British India, the records are as follows:—

1. North-Western Territory (The drainage system of the Indus so far as comprised in the plains of India, including the Punjab, the N.W.F.P., N. Rajputana and Sind). 85 species belonging to 50 genera.
2. Western Himalayan Region (from Hazara to borders of Nepal, including Kashmir). 27 species belonging to 18 genera.
3. North-Eastern Frontier Region (Nepal and eastwards, including Assam). 8 species belonging to 7 genera.
4. Indo-Gangetic Plain (U. P., Bihar and Bengal). 74 species belonging to 39 genera.
5. Burma (including the Andamans and Nicobars). 4 species belonging to 3 genera.
6. Main Peninsular Area (including S. Rajputana and the Central India Agency). 17 species belonging to 12 genera.
7. Southern Region (S. of latitude 15°). 80 species belonging to 31 genera, which record includes 40 species from the stomach of the ox.
8. Western Region (Goa to Cutch, the Ghats to the Sea). 30 species belonging to 26 genera.
9. Ceylon—60 species belonging to 19 genera, which record includes 41 species from the stomach of the ox.

In the present state of our knowledge, no importance can be attached to the presence or absence of any species in the specified regions. Larger number of species as recorded from certain regions is simply due to the fact that these regions have been better worked out. Further work will doubtless show the all-India distribution of most of the species.

Mining and Geological Institute of India.

THE annual general meeting of the Mining and Geological Institute of India was held on 1st February 1935 at Calcutta. In his presidential address W. H. Bates (of Burn and Co.) has surveyed the growth and development of coal trade in Bihar and Orissa for the last 30 years. In his opinion the slump in coal market is not merely due to the world-wide trade depression, but to other local causes; and he considers that the future is not so gloomy as many would like us to believe, especially in view of the possible shortage of oil and other combustible products. The meeting was followed by the Annual Dinner with the Governor of Bengal as the chief guest. Interesting excursions were arranged to several places like Bokaro colliery, *Statesman* offices, etc. The most important work published in the *Transactions* of the year was Dr. Heron's paper on the mineral resources of Rajputana for which the author was rightly awarded the Government of India prize of Rs. 500 and a gold medal.

Insect Transmission of Spike Disease of Sandal (*Santalum album*, Linn.).

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THE infectious character of Spike Disease having been experimentally demonstrated in a number of ways,[1,2,3,4,5] the next logical step in the investigation was to elucidate the mode of its dissemination under natural conditions. Strong circumstantial evidence, observations of previous investigators and the experience of other related diseases, led to the suspicion that the disease is possibly carried by a specific vector, the nature of which was still obscure.

Platform experiments[6] carried out since 1931 showed that the activity of the vector is confined to certain seasons of the year and that it operates above ground. Further confirmation of this fact was obtained from the natural infections which occurred among the potted sandal plants kept distributed in a heavily spiked area. The caging experiments[6] carried out in the 6-acre regeneration plot at Jawlagiri and later at Nognoor, demonstrated that the vector was effectively screened off by muslin cloth or by wire gauze of 10 to 20 meshes to the inch. The fact that the percentage of disease incidence in a given area was roughly proportional to the intensity of the infliction of scars pointed to the existence of scar-producing agencies which were also possibly responsible for the transmission of the virus. Continued observations showed that 64 per cent. of the scar-bearing plants got spiked while an incidence of only 8 per cent. could be recorded among the control plants which had not received similar injuries.

At this stage of the investigation, the Imperial Forest Entomologist, Dehra Dun, was invited to take up the problem from the entomological point of view. The extensive survey of the insect fauna associated with spiked and healthy areas carried out by Chatterjee,[7] led to the incrimination of a number of groups and individuals as vectors of Spike Disease. A series of carefully designed transmission experiments with these insects was conducted and a "mass infection cage" also was constructed into which were released the insect fauna from heavily spiked areas. Healthy and spiked sandal plants in pots were kept in the cage, so that together with the insect fauna the cage represented a "miniature sandal forest".

The above studies have resulted in the accumulation of mass of useful information and, from an entomologist's point of view, present a unique and very valuable contribution to the forest Entomology of South India. But from the point of view of the problem of insect transmission of spike, the efforts did not lead to any positive results.

A careful study of the experimental technique employed in the above series of studies showed that (1) the insects for the mass infection cage were collected and brought from areas located 50 miles away from Bangalore where the mass infection cage was situated, a circumstance which might have contributed towards the negative results; (2) Dover and Appanna[8,9] state "with the insect fauna we were no more fortunate. In October 1932, we reported a population of twenty thousand and hoped that we should be able to increase it to more than a hundred thousand. But in spite of every effort, the population fluctuated in the vicinity of twenty thousand and it was confined to a very small number of species, though at least two hundred thousand insects representing practically every species taken on sandal in the forest of North Salem, were introduced between June 1932 and March 1933"; (3) The insect fauna released into the mass infection cage mainly consisted of collections made during the day and "en masse" experiments with night fauna were not carried out. Careful and extensive observations had revealed that the scars are inflicted in large numbers during the nights[6] and this fact emphasised the importance of experimenting with the nocturnal insect fauna.

The problem of insect transmission was again taken up in May 1934 and several modifications in the light of past experience were introduced in the experiments. One of the cages was put up right in the midst of a heavily spiked area at Jawlagiri so that the insects could be released into the cage

soon after collection in a "nascent condition". The Denkanikota cage was situated 4 miles away from the centre of insect collections. The insect fauna for the cages were collected from spiked areas—both from sandal and associated host plants—during the night from 9-30 P.M. to 5 A.M. Other experimental details relating to the cages are given in Table I.

TABLE I.

	Denkanikota	Jawlagiri
Dimensions of the cage ..	24′×12′×7′	25′×12′×7′
Mesh of wire gauze ..	20 to an inch.	20 to an inch.
Date of start	7-5-1934	19-8-1934
No. of sandal plants:		
Healthy	42	37
Spiked	24	35
Total number of types introduced into the cage from commencement to date of first spiking ..	190	252
Total number of insects ..	8,421	15,766
Virulence of disease in areas from which insects were collected ..	1	5

At the commencement of the experiments it was observed that the insects did not feed on the spiked plants while on the healthy they could be seen in large numbers. With a view to render the spiked plants more attractive to insect attack, a certain number of them were planted in steel drums ($4' \times 1\frac{3}{4}'$) sunk in the ground. A number of healthy plants also were similarly planted up in the cage. These plants put on a new flush after a few weeks. A fresh batch of 23 healthy and 10 newly spiked plants bearing plenty of spiked foliage were introduced into the cage on 9—12—1934 so that the insects were given every chance to feed on the spiked plants. At the kind suggestion of Mr. M. V. Laurie, Provincial Sylviculturist, Madras (now Imperial Sylviculturist to the Government of India), the cage was partitioned on 9—12—1934 by a collapsible cloth screen. The spiked plants occupied one half of the cage while the healthy plants were placed in the other half. This arrangement enabled a control of the insect fauna in the cage, which could be driven to one or the other half of the cage and induced to feed on spiked or healthy plants as desired.

On 19—1—1935, one of the healthy plants in the cage at Jawlagiri looked highly suspicious after about 5 months and in the course of the next fortnight, the plant exhibited the characteristic symptoms of spike. Material from this plant was tal on 19—2—1935 to Denkanikota and utili for grafting 6 healthy plants, two of wh developed the disease on 28—5—1935, th confirming that the spike symptoms p duced through the agency of insects w transmissible by grafting in just the sa manner as the natural spike tissue is capa of transmitting the disease. The infecti character of the disease produced by inse was thus established, and was theref identical with the natural spike occurrin forests not only with regard to the morp logical symptoms but also with respect its transmissibility of infection thro grafting.

On 8—3—35 two more plants belong to the same series at Jawlagiri manifes the disease. At this stage it was conside desirable to defoliate a certain number the plants still continuing healthy, wit view to force out the masked symptom any. Mr. W. G. Dyson, District Fo Officer, North Salem, kindly suggested t only 50 per cent. of the plants should subjected to this experiment while the should be allowed to remain in the ca 15 from the August and 13 from the cember batches of healthy plants w accordingly removed from the cage 9—3—1935, defoliated and were kept un observation at Denkanikota. These pl were immediately replaced by an e number of healthy plants. About the mi of April 1935, 5 among the defoliated 8 among the plants which continued remain in the cage, all belonging to earlier August series got spiked, brin up the total number of spiked plants t out of the 37 healthy plants introduced the cage at the very commencement of investigation.

It should be made clear that so far t has been no disease incidence among other two batches of healthy plants in duced into the cage in December 1934 March 1935.* These plants are being l under observation. It is remarkable, t has been no incidence among the hea plants in the Denkanikota cage. It wil seen from Table I that the insect fauna l as regards types and individuals is low in the case of the Denkanikota cage the virulence of the Denkanikota area f which the insects were collected for the i

* Since the above was sent to the press. plant in the Denkanikota cage has got spiked

infection cage, is only one-fifth of the virulence characterising the corresponding area at Jawlagiri. In the case of the Denkanikota cage, the insect collections had to be transported over a distance of four miles and were not therefore in as "*nascent*" a condition as those of Jawlagiri. These are possibly the causes for the negative results obtained so far at Denkanikota.

The remarkably high percentage of successful transmissions (43·2%) obtained at Jawlagiri in the mass infection cage, constitute a fundamental advance in the problem of spike disease investigation. The experiments establish that (1) the disease is insect-borne, (2) the insect-vectors occur during the nights, (3) that the vector responsible for disease transmission belongs to one of the 265 types introduced into the cage. On the basis of the frequency of occurrence, seasonal and regional distribution, numerical strength, their morphological characteristics and their reputation as vectors of allied diseases, a large number of groups and individuals have been eliminated, and the scope of our transmission studies with individual species has accordingly been restricted for the present, to three types of *pentatomidæ*, two of *jassidæ* and three of *fulgoridæ*. Transmission studies with these eight insects are now in progress.

Our best thanks are due to Mr. Dyson, D.F.O., North Salem, for his keen interest, constant encouragement and helpful criticisms during the entire course of these investigations, and to Mr. M. V. Laurie, Provincial Sylviculturist, for his many constructive suggestions. Our grateful thanks are also due to Sir C. V. Raman, Kt., F.R.S., N.L., and Dr. V. Subrahmanyan for their kind and continued interest in the investigation.

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[7] Chatterjee, *Investigations on the Spike Disease of Sandal*, 1 and 2, 1931.

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[9] Dover and Appanna, *Indian For. Rec.*, 1934, **20**, Pt. I.

The Science of Rubber.*

AMONG the natural products which have influenced the progress of modern civilization, rubber occupies a pre-eminent position. The discovery of vulcanisation in the middle of the last century marks the beginning of its technological development while the advent of the pneumatic tyre, the increasing employment of power vehicles and the air craft paved the way for the utilisation of rubber on a gigantic scale. The special and exclusive properties of this raw material, more particularly, its elasticity, high impermeability to gases and liquids, resistance to shock and sound, electrical insulation and a marked resistance to chemical attack, properties which characterise no other single individual material of construction, have been exploited to the fullest advantage by technologists and in this endeavour, they have been assisted by an army of investigators who have contributed to the fundamental aspects of the science of rubber which constitutes the main thesis of the book under review.

The author who was entrusted with the responsible task of solving the problem of war time rubber emergency in Germany had a very enviable opportunity of enriching his experience and this fortunate circumstance has secured for the volume a prestige and authority which none will grudge. The diffcult situation was successfully met by the author and his colleagues whose strenuous efforts in perfecting the process are still being continued. The personal touch of the author is refreshingly perceivable as one goes through the pages of the book.

In this short review it is not possible to do justice by referring to all the excellent aspects of this book, but it is sufficient if attention is called to a few of the most notable features of this volume and indicate the comprehensive and thorough manner in which the subject has been approached. Such a fine production has been made possible through the combined efforts of

* *The Science of Rubber*, edited by Prof. Dipl.-Ing. K. Memmler. Authorised English Translation—Edited by R. F. Dunbrook and V. N. Morris. (Reinhold Publishing Corporation, New York, 1934.) $ 15.00.

several experts who are entitled to speak with authority in their respective fields. The editors of the English translation have maintained the same ideal in view and have selected translators from among the Firestone Research staff, who are best qualified to translate the section of the book apportioned to them. The translators' notes and comments, which appear as footnotes, constitute a valuable feature of the English translation since they amplify, corroborate or supplement the information and thus furnish the reader with an enlarged and extended experience covering the newer developments since the German original was written.

The chapter on the Chemistry of rubber has an added interest since it includes a résumé of the work on the synthesis of rubber conducted in Germany under the stress of war, in the course of which a number of normal and abnormal types of artificial rubber were produced. It is not improbable, that in the near future, most of these will find an appropriate use in industry.

The chapter on vulcanisation, the fundamental process responsible for the phenomenal development of rubber industry, treats with all the latest theories of vulcanisation and accelerator action and indicates the future lines of development. To those interested in the physical properties of rubber, the chapter on the physics of rubber will offer the most interesting and stimulating reading. The colloid chemist in particular will welcome this chapter since it deals with the swelling and solution of rubber and provides him with an array of problems requiring elucidation. It may, however, be mentioned that in the course of reading the book one gets the impression that the pure research that has been conducted on the various aspects of rubber have an intimate bearing on the industrial application. For example, the results on the permeability of rubber to gases in the relation to the quality and treatment of rubber, which has been investigated so thoroughly have been exploited in the development of aeronautics. The optical and electrical properties of rubber and its solution, which are of great technical importance, have also been treated.

For the first time, the physical methods of testing rubber have been brought together in a single chapter and this constitutes a very valuable contribution from the point of view of a technologist since most of these methods suggest possibilities of application in other fields of technology, more particularly in the fields of resins and plastics.

The chapter on the microscopy of technical vulcanizates, describes methods by which rubber can be investigated by reflected and transmitted lights as also by the dark field illumination, and these observations are illustrated by a series of faithfully and beautifully reproduced colour plates.

The fact that the Firestone Tyre and Rubber Company have permitted the members of their technical staff to engage themselves in this work of translation not only speaks of their progressive ideas but also of the high esteem in which Memmler's book is held by rubber technologists. This treatise on the science of rubber will be gratefully welcomed not only by those interested in the science and technology of rubber, but also by those interested in allied fields. It is hoped that the enterprising publishers who deserve to be congratulated in publishing this volume, will soon bring out an equally authoritative and comprehensive companion volume on the technology of rubber.

M. S.

Archæological Discoveries at Narunjadharao.

CONSIDERABLE importance is attached to the discoveries of Mr. U. T. Thakur, a young Sindhi Scholar at Narunjadharao, in Khairpur State. Experimental excavations have yielded interesting relics such as shells, bangles, images of Buddha, gold and copper, skeletons and pottery. It is anticipated that these discoveries will throw considerable light on the Mohenjadharao civilisation and the site will be revealed to the world as a centre of pre-Aryan culture. It is reported that Professor Ghory of Bombay has supported the claims of the discoverer. The State authorities have reserved the sites for further excavation and further work will be started in the coming winter.

Aquarium Fishes.*

IT is hardly realised that the ponds and ditches of India are full of small, brilliantly coloured fishes, some of which are greatly prized by aquarists in America and Europe. Millions of these fishes are trapped or netted every day for food purposes without the least idea that if a trade in these very fishes is properly organized, it can be a source of considerable income to the fishermen. An Englishman, whose wife and children were greatly interested at home in aquarium fishes, once enquired from the writer whether there were any aquarium fishes in India so that his family could spend a few happy hours with them every day during their stay in Calcutta. He was directed to collect fishes from any pond with a growth of aquatic plants and to his great surprise he obtained in one morning several specimens of *Brachydanio rerio*, *Esomus danricus*, *Barbus ticto*, *Barbus conchonius*, *Panchax panchax*, *Colisa lalia*, *Colisa fasciata*, *Nandus nandus*, *Badis badis*, *Ambassis lala*, etc., etc. The wealth of material is simply staggering and though in India fishes can be kept in aquaria with considerable ease, there are several points on which an aquarist needs instructions and proper guidance. Several books have been written on "Aquarium Fishes" to meet this need, but the recent book of William T. Innes of Philadelphia entitled "Exotic Aquarium Fishes" is the best work of general reference that has been published so far. Mr. Innes besides being the editor of a very popular journal "The Aquarium" is the author of "The Modern Aquarium" and "Goldfish Varieties and Tropical Aquarium Fishes". As an editor of a popular aquarium magazine, Mr. Innes is flooded with enquiries of all sorts and this has afforded him an opportunity to know what kind of an aquarium book general readers need and want.

The greatest need of an aquarist is to know how he can keep his aquarium and fish healthy and to meet this demand the author has devoted a great deal of space to "Primary Principles" dealing with oxygen, light, temperature and food. Attention is also directed to fishfoods, enemies and diseases of aquarium fishes, general management of aquarium and plants and planting. The classification of the aquarium fishes is in conformity with the rules of zoological nomenclature and in this connection the author had the benefit of the advice of Dr. George S. Myers, a great authority on the taxonomy of fishes. Each fish is properly illustrated and a vivid description of its habitat and habits is given. The author has given detailed information regarding the pronunciation of scientific names, the spawning of the egg-layers, the breeding of the live-bearers, the breeding of the Bubble-nest Builders, the hybrids and hybridising, the wholesale breeding of fishes and the sex changes in fishes. Useful hints are included about the collecting and transporting of aquarium fishes. An index of fishes and a cross index of general subject render the information contained in the book easily accessible. A special feature of the book is the inclusion of maps. There are seven small maps showing the world distribution of the 7 most important families of aquarium fishes. A world map is also given and under each species is included a key reference to the places on this map showing points from which the species has been taken. In short, the book is a compendium of much useful information concerning aquarium fishes and no pains have been spared to make it most up-to-date and authoritative. The author is to be congratulated on this production and the publishers, Messrs. Innes Publishing Company, have really brought out a work of art. The paper, the get-up, the printing, the binding, etc., are all that could be desired for the very moderate price of 5 dollars (postpaid).

S. L. H.

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* *Exotic Aquarium Fishes*, by William T. Innes. (Innes Publishing Company, Philadelphia.) Pp. 460, with 41 colour plates and 290 black-and-white illustrations. Price $ 5.

Letters to the Editor.

CONTENTS.

Note on Transport Phenomena and Quantum Mechanics.

IN a recent paper we have studied the transport phenomena by modifying Maxwell's method in the light of the new Statistical methods. The dynamics of Collision was studied by a method due to Perisco. In recent years Wave-mechanical collisional methods have been developed by several authors and Massey and Mohr have shown how collisional area obtained by the above methods can be used for studying transport phenomena.

In the present investigation we have incorporated the Wave-mechanical method for studying scattering of electrons by a positive nucleus and thus calculated the value of the constants A_1, A_2 represented by the expressions

$$A_1 = 2\pi\int I(\theta)\sin^2\theta/2.\sin\theta\, d\,\theta$$

$$A_2 = 2\pi\int I(\theta)\sin^3\theta\, d\,\theta$$

where $I(\theta)$ is the intensity of scattering, θ is the angle of scattering.

Taking Wentzel's expression

$$I(\theta) = \left(\frac{Z\epsilon^2}{2mv^2}\right)^2\int\frac{d\theta}{(\sin^2\theta/2+b)^2}$$

where Z is the atomic number, ϵ =electronic charge, m the mass and v the velocity of the electron, $b = \frac{1}{4k^2R^2}$, $k = \frac{2\pi mv}{h}$, R = distance between the two particles.

For completely ionised stellar matter $r=\frac{1}{2}\left(\frac{Am_H}{\rho}\right)^{1/3}$ where A is the average mol. wt., m_H =wt. of the H atom, ρ the density of stellar matter.

We thus have

$$A_1 = 4\pi\left(\frac{Z\epsilon^2}{2mv^2}\right)^2\left[\log\frac{1+b}{b} - \frac{1}{1+b}\right]$$

$$A_2 = 16\pi\left(\frac{Z\epsilon^2}{2mv^2}\right)^2\left[(1+2b)\log\frac{1+b}{b} - 2\right]$$

A_1 and A_2 may be computed for different cases and their values introduced into our previous formula, would lead to the evaluation of viscosity k, conductivity h, self-diffusion D and diffusion between two different gases D_{12}.

In the following tables are given values for some well-known giant and dwarf stars.

The first three stars are assumed to contain completely ionised iron while the last two completely ionised Ca-atom. It has already been pointed out that Kothari's Model-Dwarf should be treated relativistically. Here however non-relativistic values have been

Stars	Density	Temp.	Viscosity k in e.s.u.	Conductivity in gm./cal.	Self-Diffusion D	Diffusion D_{12}
Model-Giant (Chapman) ..	0·1	7×10^6	$9\cdot986\times10^{-3}$	13·3	$1\cdot998\times10^3$	14·93
Capella	0·1234	$9\cdot08\times10^6$	·02	2·70	$6\cdot6\times10^3$	10·3
Model-Dwarf (Kothari) ..	$1\cdot36\times10^6$	$1\cdot37\times10^7$	$6\cdot904\times10^2$	$1\cdot685\times10^5$	6·048	
ϵ_2 Eridani	$9\cdot8\times10^4$	10^8	3·719	$3\cdot242\times10^4$	1·350	
Sirius B	5×10^4	10^9	1·216	$1\cdot658\times10^5$	·688	
,, ,, ...	,,	10^8	1·216	$1\cdot658\times10^4$	·688	
,, ,, ...	,,	$1\cdot37\times10^7$	1·216	$2\cdot271\times10^3$	·688	

calculated for comparison. It is noticed that viscosity and diffusion are effected by density alone increasing with increasing density while conductivity is a function of temperature as well.

For the relativistic case $I(\theta)$ involves a factor $(1-v^2/c^2)$ and hence is greatly diminished while for $v\sim c$, $I(\theta)\sim0$ and hence, k, $\mathfrak{L}$ and D have zero values.

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[1] Ganguli and Mitra, *Curr. Sci.*; *Ind. Jour. Phys.*, 1934, **9,** 81.

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Note on Surface Tension and Its Variation with Temperature.

IN connection with a recent note[1] of Sibaiya "On the ratio of temperature co-efficients of surface tension and density" it may be pointed out that Cantor[2] who followed the same method as Sibaiya obtained the value of the ratio 2·33 instead of 2.

The nature of the cohesive forces has been studied in detail in recent years and the following relationship between Van der Waals force and the surface tension has been established.[3]

$$\text{Van der Waals Constant } a = 2\pi\int_0^R \psi(z)dz$$

$$\text{Surface Tension } \gamma = \pi\rho^2\int_0^R z\psi(z)dz$$

Lately London[4] has given a quantum-mechanical expression of Van der Waals force. According to him the interaction energy between two similar molecules is given by

$$\epsilon = -\tfrac{3}{4}\cdot\frac{\alpha^2 J}{R^6} = \frac{k}{R^6}$$

where J is the ionisation potential, α the polarisability and R the distance between the molecules. This corresponds to the potential $\psi(z)$ of Laplace. By introducing the above expression for $\psi(z)$ we have

$$\gamma = \frac{\pi k\rho^2}{4d^2} \quad .. \quad .. \quad .. \quad .. \quad (1)$$

Expression (1) was derived by Gyemant[5] as well by considering the surface energy originating from electric dipole.

By differentiating (1) with respect to T

$$\frac{d\gamma}{dT} = \frac{2\pi k\rho}{4d^2}\frac{d\rho}{dT} - \frac{\pi k\rho^2}{4}\cdot\frac{2}{d^3}\cdot\frac{dd}{dT} + \frac{\pi\rho^2}{4d^2}\cdot\frac{dk}{dT}$$

or,

$$\frac{1}{\gamma}\cdot\frac{d\gamma}{dT} = \frac{2}{\rho}\frac{d\rho}{dT} - \frac{2}{d}\cdot\frac{dd}{dT} + \frac{1}{k}\cdot\frac{dk}{dT} \quad .. \quad (2)$$

If β be the co-efficient of cubical expansion = thrice the co-efficient of linear expansion,

$$\frac{1}{\gamma}\cdot\frac{d\gamma}{dT} = -2\cdot66\,\beta + \frac{1}{k}\frac{dk}{dT} \quad .. \quad .. \quad (3)$$

Now in order to study the effect of temperature on k we must remember that

$$k = -\tfrac{3}{4}\,h\nu_0\alpha^2, \text{ where } \alpha = \alpha_0 + \frac{\mu^2}{3kT},$$

$$\nu_0 = \frac{c}{\sqrt{m\alpha}} \text{ and } h\nu_0 = J.$$

If there is no permanent dipole moment $(\mu=0)$ α and ν_0 and so k are independent of temperature. On the other hand if $\alpha_0 \ll \frac{\mu^2}{3kT}$, the expression for surface tension reduces to the formula similar to Gyemant's and

$$k = -\tfrac{3}{4}\cdot\frac{hc}{\sqrt{m}}\cdot\frac{\mu^3}{(3k)^{3/2}}\cdot\frac{1}{T^{3/2}}, \text{ and}$$

$$\frac{1}{k}\cdot\frac{dk}{dT} = -\frac{3}{2T}.$$

It should however be noted that London's

formula is to be modified for complex substances such as liquids and solids. That solids have surface tension has now been pretty well established. In the case of adsorption of gases the adsorbed molecules are held to the surface of the adsorbent by cohesive forces. Now it has been observed that the same adsorbent may adsorb varying amounts of adsorbent, when subjected to different treatment. Activation of charcoal is a familiar instance. It is supposed that the specific surface increases with activation. Now if the total surface energy be the same then the increase of surface would be associated with the decrease of surface energy per unit surface and this would lead to a corresponding decrease of adsorption per unit area. This is not actually the case. The total adsorption increases and if the adsorption per unit surface is the same, this would mean constancy of surface energy. Thus for solids it is preferable to study surface tension by considering the surface density of molecules distributed over surface, the surface layer being one or several molecules thick and this ρ in the expression (1) should be replaced by $1/\Omega$, Ω being the available surface.

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Colloidalisation and Cold-Working of Metals.

THE subject of the magnetic properties of non-ferromagnetic metals has attained much interest recently in view of the work of Pauli, Sommerfeld and others on the theory of the metallic state.[1] The simplest picture of the metal that will suit our purpose consists of a lattice of metallic ions, the remaining electrons in each atom being associated with two or more nuclei and considered as free or partly bound in accordance with their relative energy values. The susceptibility of the metal is to be considered as the sum of the susceptibilities of the ions and of the remaining or valency electrons of the individual atoms. The first part is a constant while the second is greatly influenced by the physical conditions. The large deviations in the values for metals obtained by different workers is to be attributed to the fact that their metals were not in the same state and hence the susceptibility of the valency electrons should have been greatly different.

The valency electrons may have large orbits as contemplated by Ehrenfest[2] for graphite and by Raman[3] for bismuth. Or they may be attached loosely to two close atoms, being considered as free or partly bound. On colloidalisation, the first type would give rise to decreased diamagnetism due to the fact that large orbits could not be possible at the surface. This conclusion has been experimentally established for graphite[4] and bismuth,[5] and in fact, in the case of graphite, Krishnan and Ganguli[6] have determined the direction of largest variation as the one parallel to the hexagonal axis.

In the case of good conductors, the state of affairs is different. The electrons on the surface of the atoms may be considered as free, the number of such electrons being of the same order as the number of atoms in the metal. Considered as free, the electrons possess the Pauli paramagnetism and if regarded as confined to a series of energy bands, they contribute a diamagnetic component.

Honda and Shimizu[7] have shown that cold-working in the case of copper and silver gives rise to increased diamagnetism. They have quantitatively accounted for this result as being due (1) to the decrease in paramagnetic component due to the diminution of free electrons caused by the expansion on cold-working (for which there is ample evidence from X-ray data[8]) and (2) to the increase in the diamagnetic component due to the increased number of bound electrons. They explain that the lattice constant is a little greater in the surface layer than in the interior, the normal value for the metal being reached at some hundred layers below the surface. Thus colloidalisation should be accompanied by increased diamagnetism quite similar to what is obtained in the case of cold-working.

Attention has been drawn to this similarity in the case of tin by Honda and Shimizu.[9]

I have recently verified this result in the case of copper. Colloidalisation by condensed electric discharge in an inert organic liquid in the absence of air, gives rise to an increase in the diamagnetic susceptibility. The question of impurities affecting the measurements does not arise here since all the ordinary compounds of copper are paramagnetic or less diamagnetic than the metal. Here then we have a new kind of increased diamagnetism on colloidalisation.

I take this opportunity of drawing attention to a recent letter in these pages by Verma and Gupta.[10] They have once again drawn attention to the old question of impurities modifying the results. I shall content myself here by just mentioning that they have not been fair to the literature on the subject. It is enough if mention is made of the fact that the fundamental experiment which settled the decrease of diamagnetism on colloidalisation in the case of bismuth was the observed recovery of the value of 1·32 (the value for the mass metal) on melting and cooling of a sample of the colloidal bismuth. In the rather profuse literature they have cited, they have omitted to quote the one paper[5] which outlined this conclusive experiment.

Full details will appear shortly elsewhere.

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June 30, 1935.

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[1] For a brief summary see Stoner, *Magnetism and Matter*, chapter XIV.

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[3] *Nature*, 1929, **123**, 945.

[4] *Ind. Jour. Phys.*, 1929, **4**, 139; 1930, **5**, 559; 1931, **6**, 241.

[5] *Ind. Jour. Phys.*, 1932, **7**, 35.

[6] *Curr. Sci.*, 1935, **3**, 472.

[7] *Nature*, 1933, **132**, 565.

[8] *Phil. Mag.*, 1934, **18**, 495.

[9] *Nature*, 1935, **135**, 108.

[10] *Curr. Sci.*, 1935, **3**, 611.

A Note on the Bond Energies from Raman Frequencies and Thermochemical Data.

GANESHAN[1] has measured the Raman frequencies corresponding to the Se=O and S=O bonds. From the data collected by him, it is clear that there is a general agreement between the bond energy values got from light scattering and those obtained from thermochemical data. A closer examination, however, reveals an appreciable discrepancy between the values of the heats of dissociation calculated from the Raman frequencies and those obtained from the thermochemical data relating to the *ions*. The present note deals with the significance of this disagreement.

It is to be noted that the heats of formation of the ions SeO_4^{--}, SeO_3^{--}, SO_4^{--} and SO_3^{--}, as given in the *International Critical Tables* (**5**, p. 178) are only relative in so far as they are calculated by arbitrarily assuming that the heat of formation of $H^+_{(aq)}$ from H_2 (in its standard state) is zero. In view of this fact, the values calculated by Ganeshan are to be interpreted as follows:

$$H_{2(\text{gas, 1 atmos.})} + Se_{(\text{solid})} + 2O_{2\,(\text{gas, 1 atmos.})} + aq \rightarrow 2H^+_{(aq)} + SeO_4^{--}{}_{(aq)} + 147 \text{ K. cals.} \quad (1)$$

$$4O \rightarrow 2O_{2(\text{gas, 1 atmos.})} + 232 \text{ K. cals.} \quad \cdot\cdot \quad (2)$$

Combining equations (1) and (2), one gets

$$H_{2(\text{gas, 1 atmos.})} + Se_{(\text{solid})} + 4\,O + aq \rightarrow 2H^+_{(aq)} + SeO_4^{--}{}_{(aq)} + 379 \text{ K. cals.} \quad (3)$$

Since the heat of formation of $H^+_{(aq)}$ is not known, that of $SeO_4^{--}{}_{(aq)}$ cannot be calculated. Furthermore, the heat of reaction as given in equation (3) does not give the absolute value of the heat of formation of SeO_4^{--}, so that one cannot expect it to agree with the value got from the Raman frequency of the Se=O bond.

The question then arises as to whether the Raman frequency gives an idea of the absolute heat of formation of SeO_4^{--} *ion* in solution. If this is true, one can put

$$Se_{(\text{solid})} + 4\,O + aq + 2\ominus \rightarrow SeO_4^{--}{}_{(aq)} + 344 \text{ K. cals.} \quad \cdot\cdot \quad (4)$$

Combining equations (3) and (4), one gets,

$$H_{2(\text{gas, 1 atmos.})} + aq \rightarrow 2\,H^+_{(aq)} + 2\ominus + 35 \text{ K. cals.} \quad \cdot\cdot \quad (5)$$

It is also possible to calculate the heat of reaction in equation (5) by knowing the Raman frequencies of SeO_3^{--}, SO_4^{--} and SO_3^{--}. Table I gives the values so obtained.

The large variance in the values for the heat of formation of $H^+_{(aq)}$ indicates that the Raman frequencies enable one to calculate only the heat of formation of *molecules* but not of *ions* in solution.

TABLE I.

Ion whose data are employed	Heat of formation of $H^+_{(aq)}$
SeO_4^{--}	35 K. cals.
SeO_3^{--}	39 ,,
SO_4^{--}	72 ,,
SO_3^{--}	42 ,,

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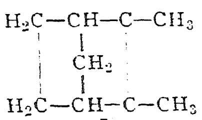
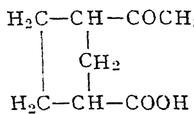
June 24, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1934, **1**, 156

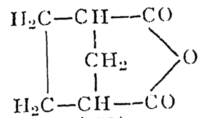
Bicyclo (1 : 2 : 3)-*octane*-2 : 4-*dione*.

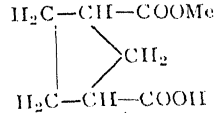
ALTHOUGH the constitution assigned to santene (I) by Semmler has been confirmed by direct synthesis,[1] the synthesis of the ketonic acids (II) isolated by Semmler and Bartelt[2] as an oxidation product of santene has not been achieved so far. The acid (II) has now been synthesised starting from *cis-cyclo*pentane-1 : 3-dicarboxylic acid and the investigation continued with a view to synthesising compounds of the type of homo*nor*camphor (VIII).

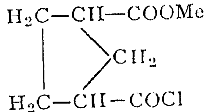

(I)

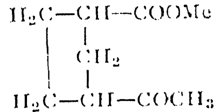

(II)

*Cis-cyclo*pentane—1 : 3-dicarboxylic anhydride (III)[3] furnishes the mono methyl ester (IV) in the usual way (b.p. 156°/4 mm.). The mono ester mono-acid chloride (V) prepared from (IV) by treatment with thionylchloride is a colourless mobile liquid (b.p. 109°/3 mm.) which gives by Blaise reaction with zinc methyl iodide the ketonic ester (VI) (b.p. 100°/2 mm. purified through semicarbazone, m.p. 139°). The ketonic acid (II) prepared from (VI) by hydrolysis boils when pure sharply at 155°/5 mm., and not within a range of 30°, *viz.*, 175–205°/10 mm. as given by Semmler and Bartelt.[2] They did not analyse this compound and it seems quite probable that their compound was not pure. The semicarbazone melts at 169° (Semmler and Bartelt 168°).


(III)

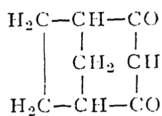

(IV)

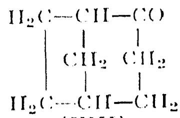

(V)


(VI)

The ketonic ester (VI) on treatment with sodium methoxide in alcoholic solution furnishes a product from which the ketonic acid (II) and a solid m.p. 123°·5 could be isolated by distillation, and subsequent treatment with petrol (obtained in poor yield). The solid gives a semicarbazone m.p. 224°, a brownish colouration with ferric chloride and evolves hydrobromic acid with bromine in chloroform solution and seems in all probability to be the bicyclic diketone (VII).

Experiments are in progress for obtaining the solid m.p. 123°·5 in workable quantities, with a view to confirming its structure as


(VII)


(VIII)

also to partially reduce it to the monoketone (VIII)—the next higher homologue of *nor*-camphor.

Full details will be published shortly elsewhere.

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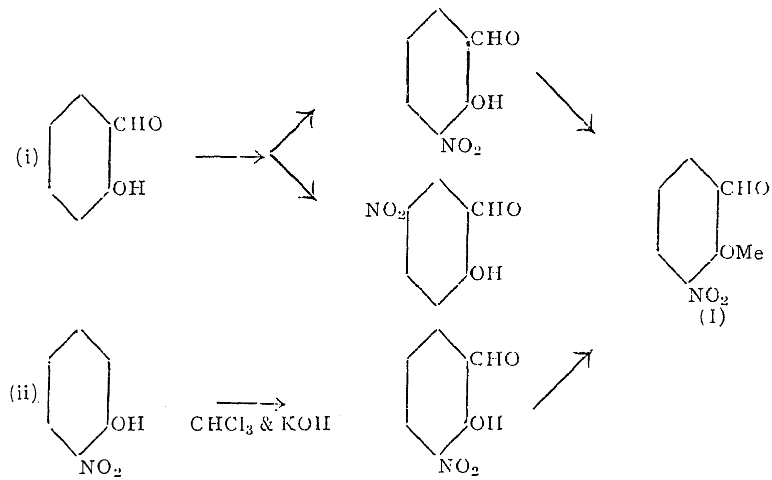
Bangalore,
July 3, 1935.

[1] Diels and Alder, *Annalen*, 1931, **486**, 205.
[2] Semmler and Bartelt, *Ber.*, 1907, **40**, 4596; *Ibid*, 1908, **41**, 128, 389, 867.
[3] Pospischill, *Ber.*, 1898, **31**, 1953; Perkin and Scarborough, *J.C.S.*, 1921, **119**, 1400.

A Preliminary Note on the Nitration of Methyl-Ether of Salicylaldehyde.

DURING the course of synthetical experiments in the group of alkaloids, we required Iso-Orthovanillin as a starting substance and it was thought that the latter might be obtained from 3-Nitromethyl-salicylaldehyde

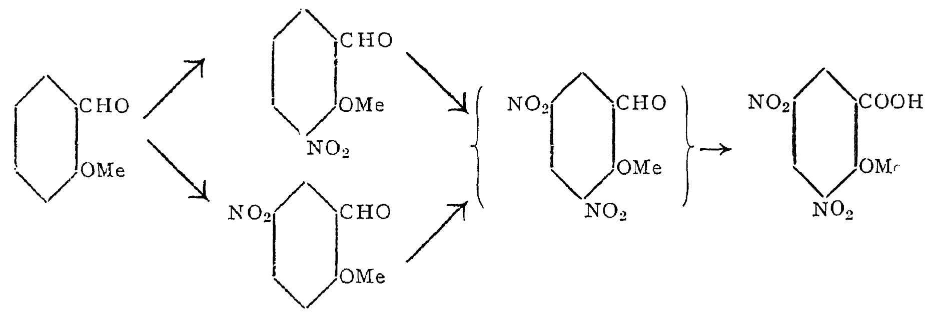
(I). 3-Nitromethyl-salicylaldehyde has so far been obtained only from 3-Nitrosalicylaldehyde which in its turn has been synthesised by two entirely different methods indicated below, one due to Miller,[1] and the other due to Sen and Ray[2] :—



Both the methods of preparation of 3-Nitrosalicylaldehyde are very tedious, and the method of Sen and Ray gives exceedingly poor yield. Further 3-Nitrosalicylaldehyde cannot be readily methylated by dimethylsulphate and alkali, and special methods (*viz.*, diazomethane or silver salt) have to be used for this purpose.[3] It was therefore thought desirable to explore methods of direct synthesis of 3-Nitromethylsalicylaldehyde.

Methyl ether of salicylaldehyde was first nitrated by Voswinckel,[4] and then by Schnell.[5] The latter author showed that if nitration were carried out with fuming nitric acid below 15°, then only 5-Nitrosalicylaldehyde-methylether is formed. These results were confirmed by Hodgson and Smith in 1930.[6] These results did not appear to the present author to be quite correct as it was thought that the 3-Nitro-compound should also have been formed just as in the case of the nitration of salicylaldehyde itself. A repetition of Schnell's experiment and careful working up of the nitration product showed that 3-Nitromethylsalicylaldehyde is actually formed in a yield of about 20%. The separation is best effected in the following manner. The crude solid nitration product is first carefully extracted with *cold* sodium carbonate solution, which extracts the dinitrosalicylic acid which is formed in small quantities at the same time. The dry residue is crystallised from benzene when 5-Nitromethylsalicylaldehyde m.p. 89° separates first. From the benzene mother-liquors petroleum ether (b.p. 30°–50°) precipitates a mixture m.p. 40°–50°. This is converted into the *p*-toluidide, and the *p*-toluidide subjected to a series of careful fractional crystallisations from alcohol. The *p*-toluidide of the 5-Nitro-compound which is only sparingly soluble in alcohol separates first in needles m.p. 165°, and from the mother-liquors the *p*-toluidide of the 3-Nitro-compound is then obtained in prismatic plates m.p. 92° (identical with the *p*-toluidide obtained from an authentic specimen of 3-Nitrosalicylaldehyde). The latter on hydrolysis gives 3-Nitromethylsalicylaldehyde m.p. 102°, identical in all respects with an authentic specimen of 3-Nitromethylsalicylaldehyde prepared by the older method—the mixed melting point being not lowered.

The results of these experiments may be briefly summarised thus :—



The detailed account of these experiments, and synthesis of Iso-ortho-Vanillin would be published elsewhere and are reserved for a future communication.

S. N. CHAKRAVARTI.

Annamalai University,
June 29, 1935.

[1] *Ber.*, 1887, **20**, 1928.

[2] *J. Indian Chem. Soc.*, 1932, **9**, 174.

[3] Compare Miller and Kinkelin, *Ber.*, 1889, **22**, 1709; Stoermer, *Ber.*, 1911, **44**, 655.

[4] *Ber.*, 1882, **15**, 2027.

[5] *Ber.*, 1884, **17**, 1382.

[6] *J. Chem. Soc. Industry*, *Transactions*, 1930, **49**, 409.

Ascorbic Acid Content of Some Plant Fluids.

IN an investigation on the occurrence of rich sources of ascorbic acid in Indian food materials, the water inside the coconut fruit and the juice sapped from coconut tree in a similar manner as in the case of date palms, as also juice drawn from the spadix of palmyra palm were examined. These juices and the coconut water are drunk as such and also as toddy (somewhat fermented juice). The following tabular statement gives a synopsis of a few observations:—

TABLE I.
Green Coconut (No Kernel yet formed).

	Volume of Water in one fruit	Natural pH	Volume of Standardised dye= mg. Ascorbic Acid for 10 c.c. Juice at pH·3
Sample 1 ..	340 c.c.	5·0	0·15 c.c. dye
Sample 2 ..	332 c.c.	4·8	0·12 c.c. dye
Sample 3 ..	320 c.c.	4·8	0·12 c.c. dye

TABLE II.
Green Coconut with Soft Kernel.

Sample 1 ..	450 c.c.	4·9	0·15 c.c. dye
Sample 2 ..	225 c.c.	5·0	0·29 c.c. dye

TABLE III.
Ripe and Dry Coconut with Hard Kernel.

Sample 1 ..	40 c.c.	5·1	0·00 c.c. dye
Sample 2 ..	150 c.c.	5·4	0·00 c.c. dye

	Volume of Water in one fruit	Natural pH	Volume of Standardised dye= mg. Ascorbic Acid for 10 c.c. Juice at pH·3

TABLE IV.
Juice from Date Palm Tree.

Sample 1 ..		4·6	1·08 c.c. dye
Sample 2 ..		4·5	1·10 c.c. dye

TABLE V.
Coconut Tree Juice.

Sample 1 ..		4·7	1·60 c.c. dye
Sample 2 ..		4·5	2·00 c.c. dye
Sample 3 ..		4·2	3·00 c.c. dye
Sample 4 ..		4·5	3·00 c.c. dye

TABLE VI.
Palmyra Palm Juice from Spadix.

Sample 1 ..		4·8	1·90 c.c. dye
Sample 2 ..		4·4	1·00 c.c. dye

Expressed juice from ripe pine apple fruits from local markets were also examined and some of the results are here given for comparison.

TABLE VII.
Pine Apple Juice.

	Fruit Material	Juice Expressed	Natural pH	Titre for 10 c.c. Juice
Sample 1	100 g.	70 c.c.	4·0	0·20 c.c.
Sample 2	100 g.	70 c.c.	4·2	1·30 c.c.
Sample 3	100 g.	65 c.c.	4·2	1·00 c.c.

In the cases of the pine apple juice it was found that only a fraction of the total ascorbic acid is pressed out. Extraction by trichloro-acetic acid gave very much higher values—4 or 5 times as much.

As indicated above in the tables 1 c.c. of the 2 : 6 dichlorophenol-indophenol dye was standardised equivalent to 1 mg. ascorbic acid.

In the above estimations it may be noted that the volume of the dye required did not vary even after suitable treatment of the juices by mercuric acetate, H_2S, etc.

It will be seen from the above that coconut water loses ascorbic acid as the fruit ripens

and gets dry. Of all the plant saps examined coconut tree juice has been found to be the richest source of ascorbic acid. The quantity of juice yielded by date palm and palmyra palm trees daily is also quite considerable, so that the ascorbic acid excreted is very high. It was noted that the ascorbic acid content did not suffer any change even after spontaneous fermentation for 24 hours.

Further details and the transference of ascorbic acid from the water into the kernel according to age of the fruit etc. will appear in the *Transactions of the Bose Research Institute*.

HIRENDRA NATH BANERJEE.
Bose Research Institute,
Calcutta,
June 25, 1935.

The Cultivation of *Artemisia*.

FOR some time past attention has been directed to the cultivation of *Artemisia brevifolia* from seeds obtained from the santonine yielding varieties of the Kurram Valley (N.W.F.P.) and the Kashmir, with a view to raising the santonine content of the wild species. It has been reported, elsewhere,* that the Kurram *Artemisia* grows well in Dehra Dun, as a garden plant, but the plants divide themselves in two sub-forms designated as the x-form and the y-form; the only distinction between the two being that one produced the flower heads early in June and the other did not show any flower heads till late in the year. It was consequently suggested that the one flowering late was the original form and the earlier flowering variety was the acclimatised form. Similar growth has been noted in the case of the Kashmir *Artemisias*. During the first year some of the plants started flowering early (May-June) and the others did not flower till November suggesting again the original and the acclimatised form. Both the Kashmir and the Kurram Valley *Artemisias* have now well established themselves and the later observations have revealed the fact that instead of the two forms stated above there is only one, but that it produces flower heads twice a year and consequently has two periods of maximum santonine content, namely, June and December. The hope that the santonine content would rise on cultivation has, however, not yet been realised. The above observations are rather interesting from the point of view of cultivation of the drug and are therefore reported. The table given below gives the santonine content of the samples collected from the minor forest products gardens of the Forest Research Institute.

Time of collection weeks		Santonine percentage	Remarks
4, August	1933	0·60	Young leaves only
4, October	1933	0·79	Buds only
1, December	1933	0·91	Leaves and buds
1, January	1934	0·78	,, ,,
1, February	1934	0·12	,, ,,
1, March	1934	0·66	Fresh leaves
1, April	1934	0·80	Luxuriant growth but no buds
1, May	1934	0·84	,, ,,
1, June	1934	0·85	Buds making appearance
3, June	1934	0·98	Buds
1, July	1934	0·52	Early rains dropped the buds
1, August	1934	0·22	,, ,,
4, August	1934	0·62	Fresh young leaves

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B. S. VARMA.
Forest Research Institute,
Dehra Dun, U.P.,
June 12, 1935.

* Krishna and Varma, *Quarterly Journal of Pharmacy and Pharmacology*, 1933, **6**, 23.

Czapek's Synthetic Medium.

CZAPEK'S formula for synthetic medium has been in use for over thirty years for culturing fungi. It consists of nitrate, phosphate, sulphate and chloride in addition to the organic principle, which is sucrose. It has, from time to time, been modified to suit the requirements of individual workers. In 1910 Dox modified this formula to present in a nearly neutral solution unaffected by sterilisation the elements necessary for the fungous growth. The original formula contained acid potassium phosphate (KH_2PO_4), while in this modified one Dipotassium hydrogen phosphate (K_2HPO_4) was used to obtain a neutral solution. Previous to this Dox[2] had used the original formula in a modified form with different proportions of the constituent salts. Currie[3] in 1917 used acid potassium phosphate for *Aspergillus niger*.

During the preparation of Czapek's solution as modified by Dox it was frequently noticed that the addition of ferrous sulphate solution gave traces of milkiness, while the

latter formula, according to which acid potassium phosphate was used, gave a clear solution as reported by Thom.[1]

On being heated to a high temperature in the autoclave, the milky product settles down as a bulky precipitate. The precipitate consists of magnesium phosphate with traces of iron. Thom[1] and later, Thom and Currie[4] have also noticed traces of precipitated magnesium phosphate.

In this note an attempt is made to study the chemical reactions of the constituent inorganic salts and the effect of the high autoclave temperature on the reactions. One per cent. solutions of pure salts in distilled water were used.

Magnesium sulphate and di-potassium hydrogen phosphate react only at the boiling temperature, when magnesium precipitates as the phosphate. The presence of sodium nitrate alone or with potassium chloride has no effect on the reaction. But the presence of ferrous sulphate even in traces has its part in the reaction and iron is also precipitated along with magnesium even at the ordinary temperature as well as at the boiling or autoclave temperature.

Magnesium sulphate and sodium nitrate or potassium chloride in the absence of di-potassium phosphate do not give a precipitate either at the ordinary temperature or on boiling, even when potassium chloride is present. But when ferrous sulphate is present, slight milkiness is produced, which, on boiling, disappears. When subjected to the high temperature in the autoclave ferric oxide is precipitated.

Ferrous sulphate reacts with di-potassium phosphate at the ordinary temperature even in the absence of magnesium sulphate or potassium chloride and gives a precipitate of ferrous phosphate.

Sodium nitrate and ferrous sulphate do not give any precipitate but in presence of potassium chloride some milkiness is produced which disappears on boiling.

Even in aqueous solution ferrous sulphate changes at the temperature of the autoclave into ferric oxide.

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Plant Pathological Section,
Agricultural College,
Cawnpore.

June 13, 1935.

[1] Thom, C., *U. S. Dep. Agr., Bur. Anim. Indust. Bull.*, 1910, **118**, 22.

[2] Dox, A. W., *U. S. Dep. Agr., Bur. Anim. Indust. Bull.*, 1910, **120**, 37.

[3] Currie, J. N., *J. Biol. Chem.*, 1917, **31**, 29.

[4] Currie, J. N., and Thom, C., *J. Biol. Chem.*, 1915, **22**, 289.

Sterility of Crop-Plants and a Study of Their Root-System.

STERILITY in crop-plants is fairly well known indeed; it, therefore, does not need any special elucidation. Suffice it to mention that the phenomenon is attended with abundant vegetative growth and as a consequence the sterile plant or branch, in habit looks bushy (Figs. 3 and 4). Studies based on *Trifolium alexanderinum* L. (berseem),[1]

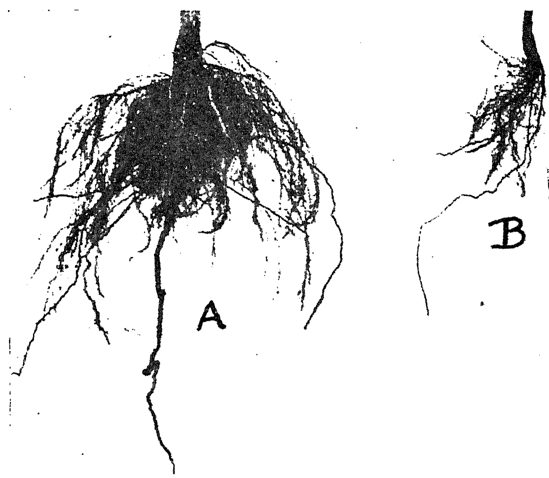

Fig. 1.

Sesamum indicum Linn. A—root-system of a healthy plant; B—root-system of a sterile plant. × 1/6.

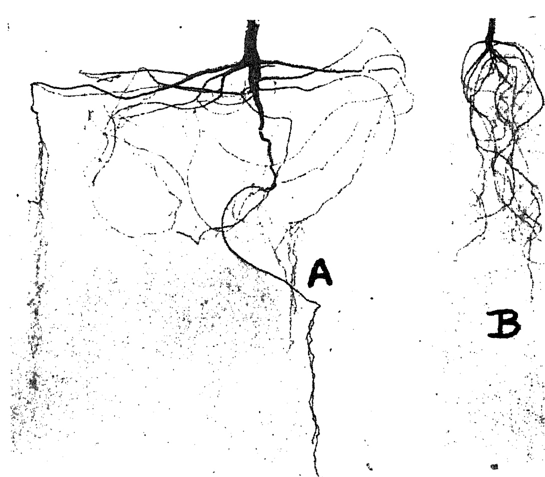

Fig. 2.

Cajanus indicus Spreng. A—root-system of a healthy plant; B—root-system of a sterile plant. × 1/20.

Crotalaria juncea L. (sunn-hemp), *Cajanus indicus* Spreng. (rahar), *Sesamum indicum* L. (til) and *Cicer arietinum* L. (gram), have

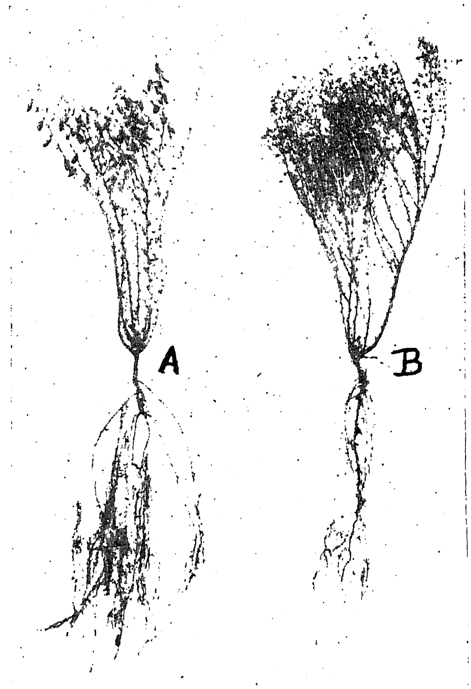

Fig. 3.

Cicer arietinum Linn. A—a normal plant with its strongly developed root-system; B—a sterile plant with its meagrely developed root-system. Note the bushy habit of the plant B. × 1/12.

shown beyond doubt that sterility observed in these is due largely to sepaloidy of petals and transformation of essential organs into very much branched shoots and leaves.[2] An extreme case, however, is found in *Cajanus indicus* Spreng. (rahar) where matters are not so clear as stated above.

A careful study of these sterile plants has evoked some interest. It has been noticed as a result of a number of root-washings that the display of root in sterile specimens is comparatively very poor, the tap- and secondary-roots being very weak and inadequate (Figs. 1-3). In addition, the number and size of root-nodules are also much smaller in the case of leguminous specimens. Whereas, in normal healthy plants, the development of the roots and nodules is fairly strong and profuse (Figs. 1-3).

This correlative study of the sterile plants and their root-system gave rise to the suspicion whether the phenomenon was not purely of a physiological nature rather than genetical as known in other crops, *e.g.*, rice.[3] At a time when this tentative conclusion was arrived at, all the crops had been harvested except *rahar* in which a number of sterile plants were available. Experiments could, therefore, be started only on one crop.

Sets of sterile *rahar* plants were treated as follows and controls were maintained as usual:

(*a*) Plants were irrigated at regular intervals with a very weak solution of pyro-phosphate of soda with a trace of potassium chloride.

(*b*) Plants were irrigated at regular intervals with very weak solution of metaphosphate of soda with a trace of potassium chloride.

(*c*) Two of the strong lateral roots in a plant were cut *in situ* and irrigated with well-water.

Fig. 4.

Crotalaria juncea Linn., a sterile shoot showing the characteristic bushy habit. × 1/6.

No difference was, however, noticed in the treated plants for about a couple of weeks after which curiously enough all of them started flowering. The control was without any flower.

These preliminary results have indicated the suspicion to be correct. It is proposed, therefore, to repeat this experiment on *rahar* and extend it to other crop-plants during the ensuing season.

I am much indebted to Rao Bahadur Viswanath (Imperial Chemist, Imperial Institute of Agricultural Research, Pusa) for certain useful suggestions.

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Sabour (Bihar),
June 29, 1935.

[1] Singh, T. C. N., *Jour. Ind. Bot. Soc.*, 1930, **9**, (4), 250.

[2] Singh, T. C. N., *Plant Breeding Abstracts*, 1933, **4**, (3), 180.

[3] Anandan, M. and Krishnaswami, V., *Curr. Sci.*, 1934, **3**, (1), 21-23.

A New Variety of Black Gram or *Urid* (*Phaseolus mungo*, Linn.).

TWENTY-FIVE types of black gram (*Urid*) have been described by R. D. Bose.[1] In the course of the examination of certain pulses at the Millets Breeding Station, Coimbatore, a new type from Malabar not described by Bose was met with. It is classifiable under "Section 2.—Black seeded types, sub-variety Niger (Bose)". The following is a detailed description of this type.

Habit: Semi-erect, profuse branching, stem furrowed, covered with long brownish hairs pointed downwards, stems green with purple splashes here and there. *Leaves*: Trifoliate, small, ovate, acuminate, leaflets ovate, entire, light green, petioles—long, hairy, channelled, sometimes purple streaked. *Flowers*: In axile racemes, peduncle purplish. Flowers lemon-yellow, back of standard purple tinged at the top, calyx purple tinged. *Pods*: Erect to sub-erect, cylindrical, unripe pods dark purple with a green tinge at the tip. Pods covered by brownish hairs pointed upwards. Dry pods dark brown in colour. *Seeds*: Oblong, small about $\frac{1}{6}$ of an inch long, flattened at both ends, black, dull, (grey back-ground with heavy black marbling).

It will be noticed that this type is characterised by its purple pods. Purple colouring on the pods of pulses is common. Some red grams have this whole or in bands. Similarly in *Dolichos lablab* this colour is whole or localised in the periphery of pods. In green gram, purple along the suture line is noted. In cowpea purple podded varieties are common especially from Malabar. These manifestations of pod purple are mendelian in behaviour. It is therefore interesting to record this new purple podded variety in black gram of potential use in hybridisation.

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N. KRISHNASWAMI.
Millets Breeding Station,
Coimbatore,
April 13, 1935.

[1] *The Indian J. of Agr. Sci.*, 1932, **2**, 625.

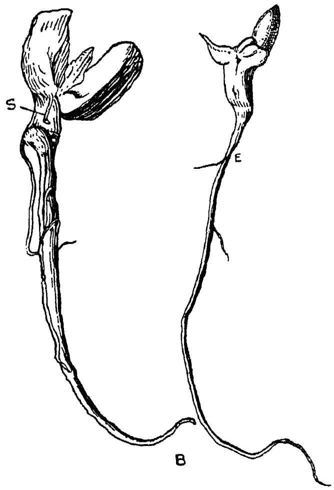
A Rare Instance of Poly-Embryony in *Arachis hypogæa*, Willd.

THE occurrence of more than one embryo in a seed has been recorded by various authors from as early as 1719. Many species of various families in both Dicotyledons and Mono-cotyledons have been known to exhibit the phenomenon. It is prevalent among the common species like *Syzigium jambolanum* (*Myrtaceæ*), *Syzigium* spp. (Tiwary, 1926), *Citrus aurantium* (*Rutaceæ*) and *Mangifera indica* (*Anacardiaceæ*). In *Papilionaceæ*, poly-embryony has been noted in *glycine hispida* (Owen, 1928). But it has

A. Germinating groundnut seed showing two main roots.

not been noticed, till now, in the groundnut, even though about a million groundnut plants have been examined during the last five years. Earnst (1918), Coulter, Barnes, Cowles (*Text-Book of Botany*) recorded a number of instances of poly-embryony.

While germinating a number of varieties of groundnut for root-tips, the authors observed that one seed of the variety "Bassi" was found to produce two radicals (Fig. A). Dissection of the seed revealed two seedlings. The bigger one was quite normal and the smaller had two thin, unequal cotyledons and a normal plumule. In the seed, the cotyledons of the smaller seedling were enclosed in between those of the bigger



B. Two seedlings separated. *E.* Extra seedling. × 2
S. Stalk by which the additional seedling is attached. × 2

one. At the top of the hypocotyl where the two cotyledons meet, there was a funicle-like structure connecting the hypocotyl of the extra seedling (Fig. B). Besides this, no other structure connecting the two seedlings was found.

The sources of the additional embryo or embryos are many and the correct origin could be determined best in the embryo-sac stage, which, in this instance, was not available.

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G. V. NARAYANA.

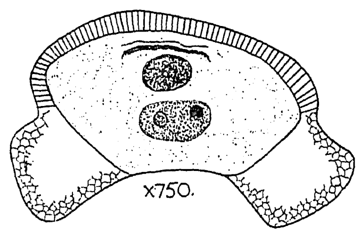
Oil Seeds Section,
Agricultural Research Institute,
Coimbatore,
June, 29, 1935.

A Note on the Shedding Condition of the Pollen Grains of *Pinus longifolia* Roxb.

POLLEN grains of all the species of *Pinus* so far investigated show two prothallial cells, one generative cell and one tube nucleus at the time of shedding (Schnarf,[1] p. 25). The only exception so far recorded is that of *Pinus longifolia* where Sethi[2] (see p. 133) reports that "Two prothallial cells are cut off while the pollen grain is still within the sporangium. These cells are more evanescent perhaps than in the other species of *Pinus* because they disorganise very soon and the pollen at the time of shedding stage shows no indications of them."

From this statement one would conclude that the development to form the tube and generative nuclei does not occur *in* the male cones. On further enquiry Dr. Sethi wrote that the mature pollen is only three-nucleate at the time of shedding and that the division to form the tube and generative nuclei occurred on the nucellus. As there are several cultivated trees of *P. longifolia* at Agra, it was suggested by Dr. P. Maheshwari that I should section some material to ascertain this point more definitely.

The first two divisions of the microspore nucleus result in the cutting off of two prothallial cells. As stated by Sethi these become flattened and disorganised very early. *The nucleus of the pollen grain divides*



A mature pollen grain of *P. longifolia.*

once again producing the tube and generative nuclei. The generative nucleus is smaller than the tube nucleus and takes a very dark stain with hæmatoxylin. It organises into a definite cell by gathering some cytoplasm around it. In spite of the ephemeral nature of the prothallial cells I could still find some favourable preparations in which all four nuclei were clearly distinguishable (see Fig.). I feel inclined to think that the material sectioned by Dr. Sethi was a little too young. The tube nucleus assumes an irregular shape at maturity.

I am indebted to Dr. P. Maheshwari for his kindly examining my preparations and confirming these observations.

B. M. JOHRI.

Botany Department,
Agra College,
May, 1935.

[1] *Embryologie der Gymnospermen*, 1933, Berlin.
[2] *Jour. Indian Bot. Soc.*, 1928, 7, 105.

On the Peculiar Apertures in the Vertebral Centra of *Hemidactylus flaviviridis* Rüppel.

In the Patna Session (1933) of the Indian Science Congress, Mookerjee and Das read a paper[1] before the Section of Zoology on the presence in *Typhlops braminus* of an aperture in the middle of the ventral surface of the centrum of each vertebra towards the anterior half. Later, Mookerjee[2] published a paper in the *Proceedings of the Zoological Society* about them. He claims that these apertures have been recorded for the first time by him. Apparently, nobody after him has so far mentioned any other animal which shows these apertures, and hence I should like to mention the case of another Indian reptile, where similar apertures are present.

For the last two years, I have been engaged in an intensive study of the Bionomics, Anatomy and Distribution of the common Indian House-Gecko, *Hemidactylus flaviviridis* Rüppel. my purpose being to supply a detailed monograph for the Series "Indian Zoological Memoirs". During the course of this work. I have prepared alizarin-stained skeletons of every stage of this gecko from the just-hatched young one to the adult. In all cases, my preparations show the presence of two apertures on the ventral aspect of each vertebral centrum, these being placed one on each side of the median line. The apertures appear to serve for the passing in of blood-vessels and are quite unmistakable. when viewed under the lower magnifications (20-40) of a microscope. It is remarkable that the apertures in this case are *two*, and not one on each centrum, as described by Mookerjee for *Typhlops*. A detailed account of the main peculiarities of the endoskeleton of *Hemidactylus flaviviridis* is in course of preparation and will be published shortly elsewhere.

Beni Charan Mahendra.

St. John's College,
Agra.
June 3, 1935.

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[1] H. K. Mockerjee and G. M. Das, "Notes on the peculiar apertures in the vertebral centra of *Typhlops braminus*."

[2] Mookerjee, H. K., "On the peculiar apertures in the vertebral centra of *Typhlops braminus*," *Proc. Zool. Soc.*, 1933, p. 283.

On the *Modus operandi* of Certain Ossicles in the Gastric Armature of Decapod Crustacea.

Mocquard[1] (1883), Pearson[2] (1908) and Patwardhan[3,4,5,6] (1934–35) have pointed out that the active movement of the gastric armature in *Decapoda* is brought about entirely by the anterior gastric muscles. Huxley[7] (1880) stated that the operation is effected by the anterior as well as the posterior gastric muscles. But the author[8,9,10] is of opinion that the active movement is the result of the contraction of the posterior gastric muscles, while the anterior gastric muscles and the cardio-pyloric constrictor muscles are mainly concerned in the restoration of the armature to its position of rest.

If the anterior gastric muscles were mainly responsible for the collision of the three teeth-bearing ossicles as suggested by Mocquard (1883), Pearson (1908) and Patwardhan (1934–35), one of the most essential factors, namely, the pressing down of the urocardiac tooth, to meet the colliding zygocardiac teeth could not be accomplished due to the reverted disposition of the propyloric ossicle (Figs. 1, 2 and 3, P.P.). For bringing the urocardiac tooth downwards, the posterior border of the propyloric ossicle which is bent over to the anterior side, has to be drawn backwards. This is possible only by contraction of the posterior gastric muscles. The anteriorly directed posterior border of the propyloric ossicle is wedged in between the exopyloric ossicles which give attachment to the posterior gastric muscles. The contraction of the said muscles results in pulling back the propyloric ossicle which, owing to the roof of the cardiac chamber, presses down the urocardiac tooth to meet the zygocardiac teeth.

The suggestions of Pearson (1908) and Patwardhan (1934–35) seem to have been entirely influenced by the statement of Mocquard (1883) who observed the action of the anterior gastric muscles in a living *Stenorynchus* having a remarkably transparent carapace. The author is of opinion that a re-investigation of *Stenorynchus* is desirable. In the fresh-water crayfish, *Astacus*, *Portunus*, American lobster, lobster, *Cancer*, *Nephrops* and *Paratelphusa*, described by Parker[11] (1876), Huxley (1880), Vitzou[12] (1882), Herrick[13] (1895), Williams[14] (1907), Pearson (1908), Yonge[15] (1924), Patwardhan (1934–35) respectively, the pro-

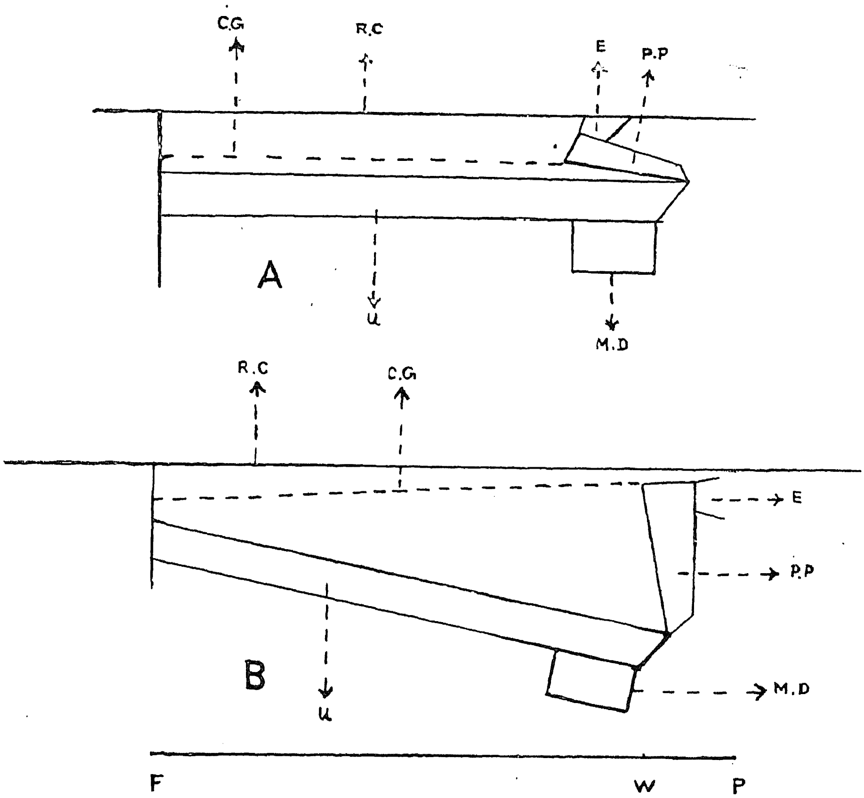

Fig. 1.

To show the action of the urocardiac ossicle.

A—Position at rest; B—Position at action.

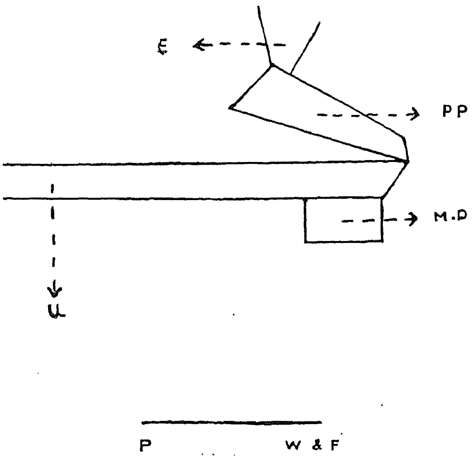

Fig. 2.

To show the action of the propyloric ossicle.

pyloric ossicle is definitely of a reverted disposition. Hence active movement of the gastric armature is possible only by the contraction of the posterior gastric muscles as indicated in Fig. 1, A and B.

Both the urocardiac and propyloric ossicles represent levers of the second order. In the case of the urocardiac ossicle (Fig. 1, A and B) the fulcrum is situated at its attachment with the mesocardiac ossicle while the power is applied at its hindermost extremity just behind the urocardiac tooth, by the anterior border of the propyloric ossicle. The power is the result of the contraction of the posterior gastric muscles and transferred to that point by means of the exopyloric and propyloric ossicles. The work is performed in the region of the urocardiac tooth. In the case of the propyloric ossicle (Fig. 2) the fulcrum is at the attachment of its anterior border with the hind end of the urocardiac ossicle and the power is applied by the exopyloric ossicles at its posterior border, while the work is done at a point near the fulcrum in pressing down the urocardiac tooth.

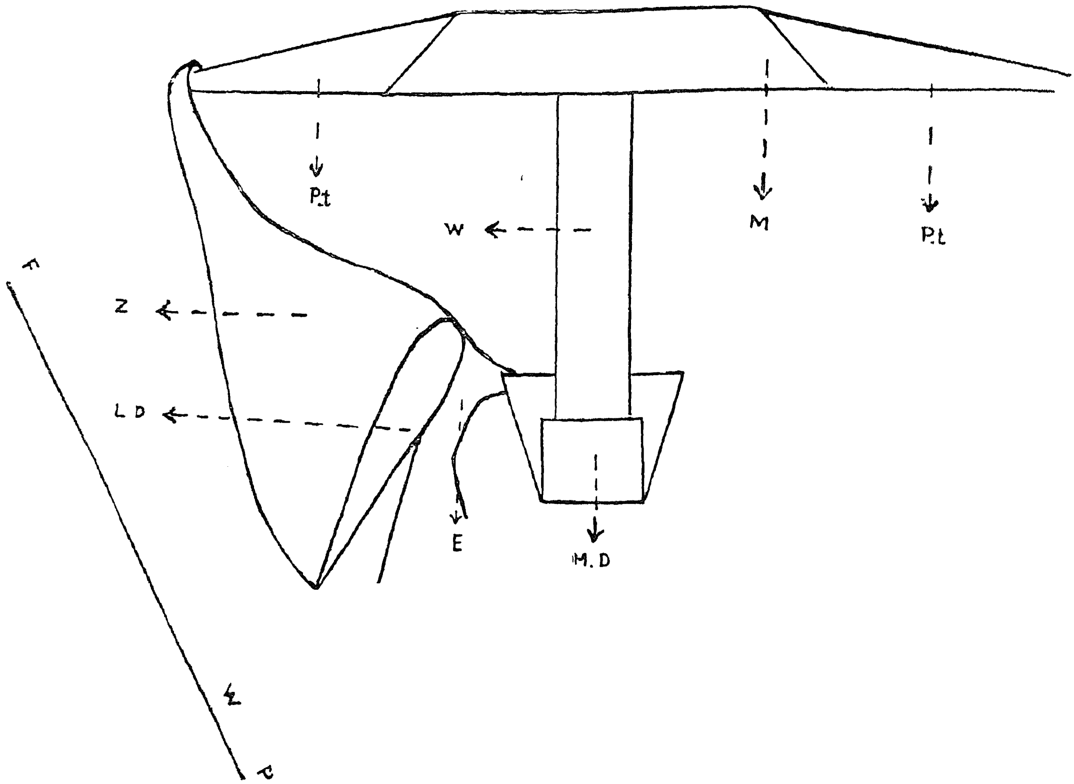

Fig. 3.

To show the action of the zygocardiac ossicle.

C. G.—Cardiopyloric Constrictor muscles; E.—Exopyloric ossicle; F.—Fulcrum; L. D.—Zygocardiac tooth; M.—Mesocardiac ossicle; M. D. Urocardiac tooth; P.—Power; Pt.—Pterocardiac ossicle; P. P.—Propyloric ossicle; R. C.—Roof of the Cardiac chamber; U—Urocardiac ossicle; W.—Weight; Z.—Zygocardiac ossicle.

Pearson (1908) on the supposition that the operation of the armature is effected by the anterior gastric muscles, locates both the point of application of power and fulcrum at the place of articulation of the zygocardiac ossicle with the outer end of the pterocardiac ossicle, while the work is turned out at the zygocardiac tooth and describes the action of the zygocardiac tooth as that of a lever of the second order considering the zygocardiac and exopyloric ossicles as a single bar. With the conditions described by him neither the zygocardiac ossicle with the exopyloric is a lever of the second order, nor is movement possible when power acts at the fulcrum. But if the power were to act at the exopyloric ossicle—as it should by the contraction of the posterior gastric muscles—then the action of the combined ossicles is that of a lever of the second order, with the fulcrum at the anterior end of the zygocardiac ossicle, the work being turned out in the region of the zygocardiac tooth and the power being applied at the exopyloric ossicle as illustrated in Fig. 3.

A. RAMAKRISHNA REDDY.
Annamalai University,
June 28, 1935.

[1] Mocquard, A., "Researches anat. sur l'estomac des Crustaces podopthalmaires", *Ann. Sc. Nat.*, 1883, **6**, *t* 60.

[2] Pearson, J., "Cancer," *L.M.B.C. Memoirs*, 1908, **16.**

[3] Patwardhan, S. S., "On the structure and mechanism of the gastric mill in *Decapoda*. 1. The gastric mill of *Paratelphusa guerini* M. Edw.," *Proc. Ind. Acad. Sci.*, 1934, **1**, No. 5.

[4] Patwardhan, S. S., "On the structure and mechanism of the gastric mill in *Decapoda*. 2. *Brachyura*," *op. cit.*, **1**, No. 7.

[5] Patwardhan, S. S., "On the structure and mechanism of the gastric mill in *Decapoda*. 3. *Anomura*." *op. cit.* **1**, No. 8.

[6] Patwardhan, S. S., "On the structure and mechanism of the gastric mill in *Decapoda*. 4. *Macrura Reptantia*." *op. cit*, **1**, No. 8.

[7] Huxley, T. H., "The Crayfish," *International Scientific Series*, 1880.

[8] Reddy, A. R., "The gastric armature of some South Indian Decapod Crustacea," *Annamalai University Journal*, 1934, **4**, No. 1.

[9] Reddy, A. R., "A note on the variations in the gastric armature of some South Indian Decapod Crustaceans," *Proc. 22nd Ind. Sci. Cong.*, 1935.

[10] Reddy, A. R., "On the structure, mechanism and development of the gastric armature of *Stomatopoda* with a discussion as to its evolution in *Decapoda.*" *Proc. Ind. Acad. Sci.*, 1935, **1**, No. 10.

[11] Parker, T. J., "On the stomach of Fresh-water Crayfish", *Jour. Anat. Physiol.*, 1876, **11**.

[12] Vitzou, A. N., "Researches sur la, et la formation des tegumentes, chez les Crustaces Decapodes," *Arch. Zool. Exper.*, 1882, **10.**

[13] Herric, F. H., "The American Lobster," *Bull. U.S. Fish Comm.*, 1895, **15.**

[14] Williams, L. W., "The Stomach of the Lobster and the food of the Larval Lobsters," *37th Ann. Rep. Comm. of Inland Fish. Rhode Island*, 1907.

[15] Yonge, C. M. "The mechanism of feeding, digestion and absorption in *Nephrops Norwegicus*," *British Journal of Experimental Biology*, 1924, **1**, No. 2.

The Presence of Uncinate Processes on the Ribs of a Lacertilian.

UNCINATE processes are present in Birds, in some Temnospondyli among Stegocephalia, in the Rhynchocephalia, and in the Crocodilia.[1] Besides *Sphenodon* and crocodiles, they have not been recorded so far in any other living reptile. It is interesting, therefore, to mention their presence in a common Indian Lacertilian.

While making a detailed study of the endoskeleton of the housegecko, *Hemidactylus flaviviridis* Rüppel, I found that four anterior ribs bear such processes. These ribs are borne on the fourth, fifth, sixth and seventh cervical vertebræ and are partially hidden by the sternum and the pectoral arches. The processes themselves are extremely delicate and usually break off in the common methods of the preparation of skeleton. They, however, become quite distinct in an alizarin-stained skeleton.

The point is an important one, as it adds one more fact to the resemblances of some of the least specialised Lacertilia to *Sphenodon* and may be significant in the discussion of the latter animal's affinities. As is well known, some authorities[2] regard *Sphenodon* as the sole living representative of a primitive order of the Reptilia and consider it to be equal in rank to the other orders of this class. As opposed to this view, other zoologists[3] think that the differences between some Lacertilians and this animal are "not so great as to justify placing it in a separate order, but, on the contrary, it should be included in the Lacertilia."[4]

Incidentally, I might also take this opportunity of mentioning that Bhatia and Dayal[5] are wrong when they say, "The vertebral column in *Hemidactylus* is composed of 6 cervical, 5 thoracic, 15 lumber, 2 sacral, and large number of caudal vertebræ." Careful counting in alizarin-stained skeletons shows that the cervical vertebræ are eight and the lumbars thirteen, the total number of precaudal vertebræ being 28. These numbers also appear to tally remarkably with those of *Sphenodon*, as given by Howes and Swinnerton,[6] *viz.*, 8 cervical, 3–4 thoracic, 13–14 lumbar, and 2 sacral vertebræ, making a total of 26–28 precaudals. The difference in the numbers of the thoracic and the lumbar vertebræ of these two animals can be explained by the facts that the sternum in *Sphenodon* has no posterior continuations like that of *Hemidactylus* and that two of the thoracic ribs in the latter animal are connected to these continuations.

BENI CHARAN MAHENDRA.

St. John's College,
Agra,
June 3, 1935.

[1] Goodrich, E. S., *Studies on the Structure and Development of Vertebrates*, MacMillan, 1930, page 78.

[2] Günther, A., "Contributions to the Anatomy of *Hatteria* (*Rhynchocephalus*, Owen)", *Phil. Trans.*, 1867, **B, 167.**

[3] *E.g.*, Huxley.

[4] O'Donoghue, Chas. H., "The Blood Vascular System of the Tuatara, *Sphenodon punctatus*", *Phil. Trans.*. **B, 210,** 240. (He himself, however, does not subscribe to this view.)

[5] *Anat. Anz.*, **Bd. 76,** Nr. 23/24, page 432.

[6] *Trans. Zool. Soc.*, 1901, **16,** Part I.

The Hosts of *Eupelmus tachardiæ* How.

MAHDIHASSAN[1] under the heading "Specificity of parasiticism by *Eublemma amabilis*" raised several issues, but chiefly accused Glover for making "the glaring statement" that *Eupelmus tachardiæ* is "inimical to lac itself," and asserts that he has definitely proved it to be a parasite of *E. amabilis* caterpillars.

Replying to the above Glover and Negi[2] stated that during the last eight years many miles of lac encrustation and many thousands of *E. amabilis* larva had been examined at the Indian Lac Research Institute and that in no instance had *E. tachardiæ* been found

parasitic on *E. amabilis*, but that it had always been found endo-parasitic on the lac insect *Laccifer lacca* and ecto-parasitic on the larva of *Microbracon greeni* syn. *Microbracon (Bracon) tachardiæ*. In support of this contention a number of publications of the Lac Research Institute were cited and in particular the *Proceedings of the Indian Science Congress*, 1929 and 1933, which Mahdihassan appears to have overlooked.

Mahdihassan[3] makes the following statement "'some one has said what I say thrice is right'; acting according to the principle Negi and Glover have repeated what they have asserted twice before.[2,3] While they stress the point it is the third time their claim appears in print,—I beg equally to emphasise, thrice have they neglected to bring forth any illustrations or details with regard to the life-history of the insect or any objective information."

The *Abstract of the Proceedings of the Science Congress*, 1933, is fairly detailed and is quoted in part in the next paragraph: comparison of this abstract and Mahdihassan's statement above is interesting.

"The chalcid *E. tachardiæ* (syn. *B. annulicaudis*) is primarily an endo-parasite of the lac insect and an ecto-parasite of the full fed larva, pre-pupa and early pupa of *M. greeni* (syn. *E. tachardiæ*) a parasite of *E. amabilis* larva. The chalcid oviposits on the stages of *M. greeni* only if covered with a cocoon ......superparasitism and laying of more than one egg by the female on the same host occurs......but in either case only one egg develops to the adult. The chalcid first deposits the egg on the host and paralyses it afterwards by several stings......oviposition and longevity is described. The chalcid seems to have 14 theoretical generations in a year based on monthly life cycles."

Mahdihassan in spite of the *Abstracts of the Indian Science Congress* and other publications of the Institute, particularly the *Annual Report for the Year* 1930–1931, challenges us to produce figures and life-history data to substantiate our claim. For this reason in spite of the fact that the paper on *Eupelmus tachardiæ* has not yet been sent for final publication, we reproduce here a photograph of one of the figures shown at the Science Congress in 1933 and quote the following data.

During the last eight years during regular routine examination of lac samples a considerable number of cases have been observed of *E. tachardiæ* parasitic on both *M. greeni* and *Laccifer lacca*. In the Science Congress 1929 paper, Gupta, Negi and Misra stated that a specimen of *E. tachardiæ* had been reared from the larval stage parasitic on *Z. jujuba* lac, Mathurapur, Bengal, in March 1927, and that since then a number of males and females of this chalcid had been reared from larvæ and pupæ parasitic on lac insects at Namkum, but that it had never been found parasitic on *E. amabilis*. During the year 1930–31 *E. tachardiæ* was artificially bred in the Insectary on *M. greeni* larvæ which had spun cocoons in small glass capsules. The following life-history data were obtained, and quoted by Negi and Gupta at the Indian Science Congress, 1933.

Month in which life-history began	Egg Stage	Larval Stage	Pupal Stage	Total cycle
April 1930 ..	..	..	7 days	..
May 1930 ..	1 day	8 days	8 days	17 days
June 1930 ..	1 day	7 days	8 days	16 days
July 1930 ..	1 day	10 days	8 days	19 days
August 1930 ..	..	..	..	..
September 1930 .	..	..	7 days	..
October 1930 ..	..	..	16 days	..
November 1930 ..	..	..	34 days	..
December 1930 ..	5 days	40 days	19 days	64 days
January 1931 ..	3 days	31 days	14 days	48 days
February 1931 ..	6 days	35 days	12 days	53 days
March 1931 ..	..	..	11 days	..

In the above table the complete cycles are from *eggs laid in the Laboratory on* M. greeni *larvæ as host: where only the pupal stage is given it is taken from larvæ collected from the Field parasitic on* L. lacca.

We prefer to leave the reader to judge whether our claim that *E. tachardiæ* is parasitic on *L. lacca* and *M. greeni* based as it is on 8 years regular routine examination of lac samples, entailing the annual examination of over 100,000 lac cells and many thousands of *E. amabilis* larvæ, and further based on the actual breeding of *E. tachardiæ* on *M. greeni* in the Laboratory, has greater justification than Mahdihassan's claim that *E. tachardiæ* is parasitic on *E. amabilis* based on a single and rather doubtful instance.

The instance cited by Mahdihassan of *E. tachardiæ* parasitic on *E. amabilis* is as follows:—A larva was found attached to the body of an *E. amabilis* caterpillar, it pupated the following day. From our experience it seems possible that the *E.*

tachardiæ larva which was within a lac cell close to an *E. amabilis* larva was dislodged from its actual host *L. lacca* while dissecting the encrustation and came to lie

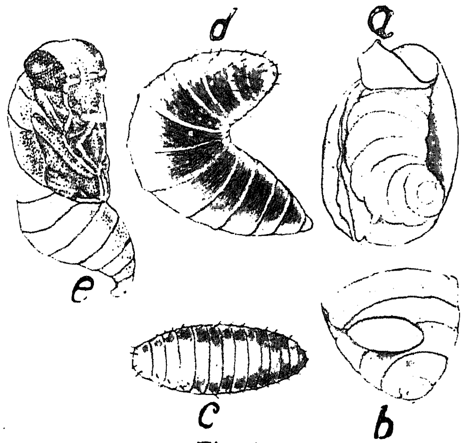

Fig. 1.

(*a*) A *Microbracon greeni* cocoon opened to show the paralysed *B. tachardiae* larva and the pencils and punctures formed between the larva and its cocoon as a result of the *E. tachardiae* (*B. annulicaudis*) pricks.

(*b*) The *E. tachardiae* egg lying over the posterior end of the *M. greeni* larva.

(*c*) Just hatched larva of *E. tachardiae*.

(*d*) Nearly full fed *E. tachardiae* larva (details not fully shown).

(*e*) The *E. tachardiae* prepupa casting the larval skin to turn into pupa.

on the *E. amabilis* larva before it was observed by Mahdihassan.

If Mahdihassan is still not fully convinced may we suggest that he try to breed *E. tachardiæ* in the Laboratory on both insects, *M. greeni* and *E. amabilis* and he will discover for himself that the former is a host of *E. tachardiæ*.

As regards Mahdihassan's other observations, we prefer at present to disregard them as they are of secondary importance and merely confuse the issue of the present discussion regarding the host of *E. tachardiæ*.

We should like to point out, however, that our specimens of *Eupelmus tachardiæ* were identified by Dr. Ch. Ferriere of the Imperial Bureau of Entomology, an expert on the *Chalcidoidea*.

P. M. GLOVER.
P. S. NEGI.
S. N. GUPTA.

Indian Lac Research Institute,
Namkum, Ranchi,
Bihar and Orissa.

[1] Mahdihassan, *Curr. Sci.*, 1934, **3**, 260.
[2] Glover, Negi, *Curr. Sci.*, 1934, **3**, 426.
[3] Mahdihassan, *Curr. Sci.*, 1934, **3**, 562.

Alkaline Quartz-Dolerites, from Bijawar, and Their Chemical Relationships.

FOR some time the author has been working on the trappean[1] rocks which are found associated with the Bijawar system in the type area. Certain interesting results of chemical nature have been obtained and it has been thought desirable to publish them in the form of a short communication. The results of detailed investigation will be published later. A collection of rock specimens was made from intrusive masses occurring in the central part of the Bijawar outcrop. Under the microscope the rocks present a very decomposed appearance and are found to be medium-grained quartz-dolerites with a pale brown pyroxene and plagioclase felspar as their main constituents. Uralite, chlorite, biotite and epidote occur as secondary minerals. Micropegmatite occurs in the interstices, and needles of apatite are generally present. Iron oxides are very prominent and have crystallised later than the pyroxene and plagioclase. The pyroxene has been considerably altered to uralite and the plagioclase looks extremely clouded. Some plagioclase laths are so much crowded with decomposition products that they are indeterminable. Fresh felspar is rare, but when it is present it gives an extinction angle corresponding to labradorite.

TABLE I.

Chemical Comparison of the Bijawar Quartz-Dolerite with Deccan Basalt and Spilite.

	1	2	3	4	5	6
SiO_2 ..	50·30	51·00	49·50	50·27	49·68	51·22
Al_2O_3 ..	11·53	13·38	12·02	12·31	12·95	13·66
Fe_2O_3 ..	2·16	1·68	3·20	2·35	3·47	2·84
FeO ..	10·66	9·36	9·36	9·79	10·10	9·20
CaO ..	10·15	9·86	10·15	10·05	10·09	6·89
MgO ..	6·07	5·32	6·97	6·12	5·69	4·55
Na_2O ..	6·14	6·33	5·59	6·02	2·27	4·93
K_2O ..	·89	·64	1·12	·88	·52	·75
TiO_2 ..	1·23	1·13	1·17	1·18	2·00	3·32
P_2O_5 ..	·35	·42	·14	·30	·33	·29
MnO ..	·09	·08	·08	·08	·20	·25
$H_2O(+)$	·75	·90	·73	·79	1·71	1·88
$H_2O(-)$	·10	·16	·22	·16	·29	
CO_2 ..	N. D.	N. D.	N. D.	N. D.	..	·94
Incl ..	..	..	..	..	·04	..
TOTAL.	100·42	100·26	100·25	100·30	99·94	..

(1) Quartz-dolerite, Chopra, Bijawar. (2) Quartz-dolerite, Rampur, Bijawar. (3) Quartz-dolerite, near Bajno, Bijawar. Analyst: M. P. Bajpai. (4) Average of 1, 2, and 3. (5) Average Deccan basalt, H. S. Washington's analyses, 4, 12, 13, 15, 16 and 23 in *Bull. Geol. Soc. Amer.*, 1922, **33**, 774. (6) Average spilite, *Geol. Mag.*, 1930, **67**, 9.

Ilmenite, too, has been altered to leucoxene. Ophitic and sub-ophitic textures are well developed.

Three chemical analyses of the Bijawar quartz-dolerites (Nos. 1, 2 and 3) and their average analysis (No. 4) show that there is not much chemical difference between the Bijawar quartz-dolerites and Deccan basalt (No. 5) except that the percentage of Na_2O is considerably higher in the former (6·02 per cent.) than that in the latter (2·27 per cent.).

The percentages of silica, alumina, ferrous oxide, lime and magnesia in the average analysis of the Bijawar quartz-dolerites compare well with those of the same constituents in the Deccan basalt. Richness in alkali is a remarkable chemical feature of the Bijawar quartz-dolerites.

Except for the percentages of CaO, MgO and TiO_2 the analyses of the Bijawar quartz-dolerites compare fairly well with an average analysis of spilite (No. 6). In containing a high amount of soda and low percentage of potash, the Bijawar rocks exhibit some of the important chemical characteristics[2] of spilites.

TABLE II.

Chemical Comparison between Bijawar, Gwalior and Singhbhum Dolerites.

	T/1	T/2	T/84	T/86	T/59	T/14	7	8	9
SiO_2 ..	51·15	49·20	49·90	50·82	50·27	49·76	50·18	50·27	51·37
Al_2O_3 ..	12·20	11·20	11·11	13·06	11·32	11·51	11·73	12·31	14·61
Fe_2O_3 ..	2·70	1·92	2·59	1·24	1·74	1·90	2·02	2·35	·90
FeO ..	11·66	12·24	12·10	10·27	12·38	12·96	11·94	9·79	9·87
CaO ..	9·85	10·76	10·34	10·20	10·05	9·08	10·05	10·05	8·72
MgO ..	5·38	6·02	5·25	5·80	5·68	4·58	5·45	6·12	6·01
Na_2O ..	4·07	4·06	5·17	3·69	5·07	4·75	4·47	6·02	3·24
K_2O ..	·58	1·24	·84	1·01	1·06	·94	·95	·88	1·36
TiO_2 ..	·99	1·65	1·05	2·24	1·09	2·50	1·59	1·18	·89
P_2O_5 ..	·76	·47	·44	·86	·75	1·14	·74	·30	·13
MnO ..	·36	·45	·75	·48	·38	·56	·50	·08	·12
$H_2O(+)$ ..	·46	·78	·75	·67	·49	·52	·81	·79	2·34
$H_2O(-)$ ..	·24	·17	·20	·19	·26	·16		·16	·07
CO_2 ..	..	..	..	..	..	..	..	..	·29
S ..	..	..	..	..	..	..	..	..	·04
TOTAL ..	100·40	100·16	100·49	100·53	100·54	100·36	100·43	100·30	99·96

T/1, T/2, T/84, T/86, T/59–Quartz-dolerites and T/14 Basalt—from neighbourhood of Gwalior. Analyst: M. P. Bajpai, *Jour. Geol.*, 1935, **43**, No. 1, 69. (7) Average of the six Gwalior rocks. (8) Average of three Bijawar quartz-dolerites. (9) Newer dolerite from N.E. of Belma. Analyst: L. A. N. Iyer, *Rec. Geol. Surv. Ind.*, 1932, **65**, pt. 4, 528.

The quartz-dolerites from Gwalior, which have been previously studied[3] by the author, and those from Bijawar are composed of the same mineralogical constituents. The presence of micropegmatite and ophitic and sub-ophitic textures, and indications of late crystallisation of iron oxides are three very important microscopic characters common to the rocks from both the areas. Table II shows that, as far as the percentages of silica, alumina, ferric oxide, magnesia and lime are concerned, there is a close chemical agreement between the Gwalior and Bijawar quartz-dolerites. It has already been shown[4] by the author that the Gwalior trap contains a higher amount of soda than the Deccan basalt. High soda content in the Gwalior and Bijawar rocks, together with fairly uniform percentages of other constituents, indicate a close relationship between them. Average soda in the Gwalior trap is 4·47 per cent. and that in the Bijawar dolerites 6·02 per cent. The maximum amount of soda in the Gwalior and Bijawar rocks is 5·17 per cent. (No. T/84) and 6·33 per cent. (Table I, No. 2) respectively. The relatively higher amount of soda in the Bijawar quartz-dolerites seems to be related with their highly altered state because in other respects they closely resemble the quartz-dolerites of Gwalior.

Holland, in his paper, "On some Norite and associated basic dykes and lava-flows in Southern India" has shown that the trappean rocks which are found associated with the Gwaliors and Bijawars remarkably agree[5] with the augite-diorites of the Cuddapah lava-flows in petrological characters. A chemical study of the rocks from Gwalior and Bijawar shows that richness in alkali seems to be a regional feature of these supposed equivalents of the Cuddapah

lavas. Recently L. A. N. Iyer has described some "Newer dolerites" from Singhbhum which also resemble[6] Holland's augite-diorites. It is interesting to note that they also show alkaline tendencies, the total of soda and potash being considerably high in all the analysed[7] specimens of the Newer dolerites. Iyer's specimen from Belma is particularly rich in alkalies (Table II, No. 9).

The Bijawar quartz-dolerites contain an abnormally high amount of soda. An advanced stage of decomposition of their plagioclase felspars arouses suspicion that the enrichment in soda is probably due to the partial albitization of the original labradorite felspar. The felspars (with their decomposition products) and the pyroxene are under detailed investigation.

M. P. BAJPAI.

Department of Geology,
Benares Hindu University,
June 10, 1935.

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1 *Mem. Geol. Surv. Ind.*, **2**, 43.
2 *Geol. Mag.*, 1911, **43**, 205.
3, 4 *Jour. Geol.*, 1935, **43**, 61–75.—On page 69 of the Journal two mistakes have unfortunately occurred in the statement of analyses of the Gwalior trap. The value for MgO in T/14 is 4·58 and not 5·58 as printed, and the values shown against H_2O (−) are those of H_2O (+) and *vice versa*. The author has taken this opportunity of correcting these mistakes and revising the average analysis in Table II of the present communication.
5 *Rec. Geol. Surv. Ind.*, 1897, **30**, 36-37.
6 *Rec. Geol. Surv. Ind.*, 1932, **65**, 530.
7 *Rec. Geol. Surv. Ind.*, 1932, **65**, 528.

Sir Montagu Webb and Silver.

SIR MONTAGU WEBB has drawn my attention to what he describes as one little inaccuracy on page xi of my paper on "Energy and Economics"[1]. I represented him as having *put aside for a time* his advocacy of an increase in silver currency. He writes that he is, as a matter of fact, pressing with greater vigour than ever for co-operation with President Roosevelt in re-opening the world's mints *to the people* to the free coinage of *unlimited legal tender silver coins*.

Actually I had no intention of suggesting that Sir Montagu had in any way abated his campaign. I merely meant that in the particular case of Karachi, silver was not specifically mentioned. If I had said "for the moment" instead of "for a time" it might have better conveyed my meaning. In any event I am glad to have the opportunity of correcting a possible false impression.

I may mention that Sir Montagu has just sent me the first five numbers of his new bulletin entitled "*Better Money*" which are full of valuable information on the subject of Monetary Reform. He tells me that he will be glad to send copies to any student of this, the most important problem of the day.

GILBERT J. FOWLER.

Central Hotel,
Bangalore,
June 26, 1935.

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1 *Curr. Sci.*, 1935, **3**, No. **11**, Supplement.

Magnetic Susceptibility of Ice.

IN a letter[1] regarding the diamagnetic susceptibility of water polymers, the susceptibilities of (H_2O), $(H_2O)_2$ and $(H_2O)_3$ have been computed using the temperature-susceptibility data of Cabrera and Fahlenbrach and the polymer abundance data at different temperatures obtained by Ramakrishna Rao. The computed value for the susceptibility of ice works out to be $-0\cdot7080 \times 10^{-6}$. At that time I was not aware of any experimental value for the susceptibility of ice. Recently, however, my attention has been drawn to a paper by Ishiwara[2] where the susceptibility value for ice is given as $-0\cdot699 \times 10^{-6}$. The calculated value shows a deviation less than 1·5% from the observed value; this in itself is a striking agreement in support of the theory. Ishiwara has further observed that the susceptibility of ice remains unaltered between −120°C. and 0°C. This would require the polymer constitution of ice to remain fairly constant between −120°C. and 0°C. It is quite probable that in ice no variation occurs, for it would demand a rearrangement of the crystal lattice. Modifications of ice, *viz.*, ice II, III, V and VI observed by Tammann and Bridgman at low temperatures and very high pressures are perhaps due to this cause. But ice I, *i.e.*, ordinary ice, cannot possibly be modified by the lowering of temperature alone. Such a hypothesis would explain the observed constancy of the magnetic susceptibility of ice between −120°C. and 0°C. at atmospheric pressure. It must, however, be admitted that the above assumption requires experimental confirmation.

L. SIBAIYA.

Department of Physics,
Central College,
Bangalore,
July 8, 1935.

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1 *Curr. Sci.*, 1935, **3**, 421-22.
2 *Rep. Tohoku Imp. Univ.*, 1914, **3**, 303.

Chemistry in the Customs Department.*

By H. B. Dunnicliff,

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Introduction.

In 1905 the attention of the Government of India was drawn to the inferior quality of country spirit consumed by the Indian people and Lt.-Col. (afterwards Sir Charles) Bedford, I.M.S., was appointed to investigate matters. Assisted by Messrs. Jenks and Day and two Indian Laboratory assistants, he carried out the pioneer work in India on spirit examination and estimation. They studied the contamination of spirits with copper and zinc and prescribed easy tests for their detection. They also developed methods for distinguishing between illicit spirits and those distilled under Government permits, mainly by the detection of common impurities present, and prepared an official Technical Excise Manual. This work had the dual effect of improving country spirits and conserving excise duty.

Determination of Spirit Strength.

The term "Spirits" was used to mean the compound which is most commonly produced in fermentation processes and which is properly called "ethyl alcohol" or more commonly just "alcohol". Ethyl alcohol is, however, only one of a series of compounds having similar or related properties and the term "Spirits," both in Great Britain and India, now includes pure methyl alcohol which is produced in large quantities by several commercial processes.

In India, the term "Spirits" covers all alcohols the proof strength of which can be readily ascertained. Such alcohols must be miscible with water in all proportions and, at a temperature of 51° F. have, in the pure state, a specific gravity relative to water of not more than 0·923. These conditions are satisfied by methyl, ethyl, normal-propyl and isopropyl alcohols.

The spirit strengths are determined by two methods, the hydrometer and the pyknometer or specific gravity bottle.

Sikes Standard Brass Hydrometers were originally used but Sir Charles Bedford stated that they are not very suited to Indian conditions and he prepared tables for the use of instruments made of glass and, in a simple mixture of alcohol and water, the amount of alcohol present can be determined directly by these instruments.

If, however, some other substance is present in solution, such as sugar or colouring matters, the direct reading of the instrument no longer gives the spirit strength and the spirit strength is said to be "obscured" by these additional substances. Obscuration always results in an apparent lowering of the amount of alcohol present and consequently in the loss of revenue if not properly calculated and adjusted. Its determination in alcoholic liquors is one of the important functions of customs and excise chemists.

In obscured liquids, spirit strength is determined by distilling off the alcohol and finding the spirit strength of the distillate by the hydrometer or pyknometer. In some cases, the distillate contains substances other than spirit such as essential oils or volatile compounds like camphor and these have to be separated before the correct spirit strength can be reported.

For some years spirit strengths were determined in the Gauging Departments of Custom Houses and Mr. Jenks who, until 1928, was Chemical Examiner for Customs and Excise at the Calcutta Custom House was called upon to investigate and report on the best method for the determination of the spirit strength and obscuration of spirituous liquors imported into India.

The United Kingdom procedure using the Sikes brass hydrometer was ultimately adopted and all ports have their instruments adjusted at Calcutta where there are standard instruments, which are periodically tested at the Government Laboratory in London.

Denaturation.

Alcohol is an essential constituent of many commercial articles such as "methylated spirits", varnishes, a number of medicinal preparations and many others.

In order that alcohol may be available for arts and industries as well as for domestic purposes, it must be cheap but it must be "denatured," *i.e.*, made too unpleasant to drink. Hence much work has been done to discover suitable substances to add to drinkable pure or nearly pure alcohol, the so-called "rectified" or "silent" spirits, to make them so nauseating and repulsive that even the strongest palate could not tolerate the taste. Substances added to pure alcohol for this purpose are called "denaturants".

The selection of an official denaturant for India was investigated by Sir Charles Bedford and Mr. Jenks with the co-operation of Messrs. D. Waldie & Co.

The properties required of an ideal denaturant are very exacting and may be detailed as follows. It must be a combustible volatile liquid, soluble in alcohol, having an unpleasant taste and smell and not be easily separable from the spirit by physical or chemical means. It must not be poisonous nor have any injurious effect on the human body and must be available in large quantities at low rates.

Very few substances have all these properties and a fortune awaits the discoverer of new and better denaturants than those at present available.

Spirit is denatured in India by the addition of two substances: the first is one of the distillation products of old vulcanised rubber, such as old motor tyres, and is called "light caoutchoucine," the other is "pyridine bases of mineral origin". (Pyridine bases can be made from animal nitrogenous refuse but their use is not permitted.)

One half per cent. of each of these substances is added to imported rectified spirits in the Custom Houses before the spirit is issued for general use as "denatured spirit" or, as it is often erroneously called "methylated spirit".

* An abridged version of a public lecture given at the meeting of the Twenty-Second Indian Science Congress on January 5th, 1935, in the Senate Hall of the Calcutta University.

Denaturation by other means, such as the addition of wood naphtha, is only allowed by special permission in the interests of the development of certain industries and in the case of certain IMPOTABLE preparations. Such denaturants "earmark" the spirit as "specially denatured" and the chemist is responsible for their detection.

PROOF SPIRIT.

The way in which alcoholic content is described, *i.e.*, in terms of "proof spirit," has a peculiar origin. If a light is put to alcohol, it will burn, even when it contains fairly large quantities of water. In early days, if a specimen of alcohol was poured over gunpowder and then ignited, the alcohol was said to be "under proof" if the flame ceased burning without igniting the gunpowder and "over proof" if, under these conditions, the gunpowder burst into flame. The weakest solution which just permitted the gunpowder to inflame was called "proof spirit". The strength of this spirit was accurately determined and spirit strengths are still described in terms of this arbitrary standard, *i.e.*, in degrees of proof spirit. A spirituous liquor is said to be 10° "under proof" if, from 100 volumes of that liquid, 90 (*i.e.*, 100 - 10) volumes of liquid of proof strength could be made. Thirty degrees "over proof" means that 100 vols. of that liquid could be diluted with water to give 130 volumes of proof spirit. One hundred volumes of pure alcohol would give approximately 175 volumes of proof spirit. Thus pure alcohol is 75° over proof. These values are sometimes described as percentages, for example, 30° over proof spirit is also said to be 130% proof.

POWER ALCOHOL.

One of the earliest investigations undertaken in the Customs Laboratories was an attempt to formulate a fuel for motor vehicles in an attempt to replace or supplement petrol. The Power Alcohol Committee appointed Mr. Jenks to carry out experimental work and he finally submitted proposals for the introduction of a fuel composed of 90% alcohol, if not less than 55° over proof, denatured with the usual denaturants and coloured with half a gram of methyl violet per gallon together with 10% of petrol, ether, benzol or other approved adjunct to act as anti-knock constituents.

ISOPROPYL ALCOHOL.

Complexity sometimes arises because the Government of India's definition of "spirit" differs from that of Great Britain in that it includes two more alcohols, normal and isopropyl alcohols. The former is not of much importance but the latter, isopropyl alcohol, called by various trade names such as "avantine," "petrohol" etc., causes difficulties as it is being used in increasing quantities in the manufacture of cheap perfumes, flavouring essences, toilet preparations and a number of other commercial products. Since this compound is not classed as "spirit" in England, cheap scents and other products like flavouring essences are often described in good faith as "free from spirit" while they contain isopropyl alcohol and, are therefore assessed to spirit duty on import into India.

Recently it was discovered that the standard chemical method for the determination of spirit strength known as the Thorpe and Holmes's method, is not reliable when isopropyl alcohol is present and a modified* form of the test has been worked out by two chemists at the Bombay Custom House and is in current use

WINES, ETC.

Some alcoholic beverages, *e.g.*, beer, porter, cider, are not tested directly, but they have to be identified. Wines not containing more than 42 degrees proof spirit, roughly 24% by vol. of alcohol, and perfumed spirits or scents are assessed by volume or gallonage.

Wines containing small quantities of medicinal substances are called "Medicated Wines". For Tariff purposes, they are assessed at a lower rate of duty than that charged on ordinary beverages containing spirit and they are classed in a separate category although, fundamentally, there is little difference between a medicated and a beverage wine. Wines containing very small quantities of medicinal substances are also sold as "aperatif wines" and claims are sometimes made for their preferential treatment as medicated wines. This is not permissible in Customs although Excise regulations allow them to be sold under a medicated wine licence in chemists' shops. An up-to-date list of medicinal, aperatif and beverage wines is maintained in all Custom Houses.

PROHIBITED AND RESTRICTED DRUGS.

Alkaloids such as morphine, cocaine and other habit-forming drugs have valuable medicinal properties and their total restriction is not desirable. The Health Committee of the League of Nations is attempting to regulate the traffic in such drugs without interfering with their use in medicines. In addition to these, a number of valuable restricted and prohibited drugs have been synthesised and the qualitative and quantitative examination of samples in pursuance of the Geneva Convention for the Regulation of Narcotic Drugs of 1925 and in the operation of the Dangerous Drugs Act is among the important duties of Customs analysts.

THE DEVELOPMENT OF THE CUSTOMS LABORATORIES.

Until 1912, the main commodity assessed to Customs duty by chemical means was "spirituous liquors". These were tested in the Custom Houses but any other imports requiring chemical examination were sent to the laboratories of the Chemical Examiners to the Local Government of the Presidency in which the Custom House was situated.

As time went on, the number of articles requiring chemical examination to provide for their correct assessment to Customs duty and the number of samples submitted increased and the complexity of the issues became more involved.

To deal with the work, a laboratory having a wider scope was opened in the Calcutta Custom House and Mr. Jenks was appointed to do all the excise work for Local Governments (except Bombay and Madras) and also to examine any Customs samples which might be submitted.

Further increase in the number of items in the Customs Tariff assessable to duty on the basis of chemical examination took place during the next fourteen years, until the range extended over foods, textiles, oils, building materials, jewellery, paper, minerals, dyes, patent preparations of all kinds and numerous other classes

***Vide Analyst*, 1935.

of goods and the necessity for a specially trained scientific staff became self-evident.

In 1926, the Government of India decided that it would be advisable to consider the establishment of laboratories in the Custom Houses at the other major ports: Bombay, Karachi, Madras and Rangoon, so as to expedite the work and have the testing carried out under the administrative control of the Collectors of Customs.

Mr. Jenks was directed to submit a scheme and, in 1927, laboratories at the Karachi and Rangoon Custom Houses were opened but the apparatus was limited and the equipment incomplete.

Mr. Jenks was put on special duty in 1928 to organise, furnish and equip the laboratories, to make recommendations regarding staff and to prepare a technical manual for the use of Customs chemists. Unfortunately, he suddenly fell seriously ill in July 1928 and had to leave India immediately.

His senior assistant Mr. (now Rai Sahib) M. N. Ghose, the present Chemical Examiner at the Calcutta Custom House, was put in charge of the laboratory but, in the following October, the Government of India appointed a special advisory officer to develop the scheme for the organization of Customs chemical work.

Laboratories suitably equipped for the purpose and staffed by qualified chemists have been fitted out in the Bombay, Karachi, Madras and Rangoon Custom Houses and the equipment at Calcutta expanded and improved. These laboratories are responsible for the testing of all samples sent for examination by the Appraisement and other Departments of the Custom House and the chemists in charge submit their reports, paying special attention to the interpretation of the Indian Customs Tariff. Each laboratory works under the direction of a Chemical Examiner or Assistant Chemical Examiner. These officers are under the administrative control of the Collector of Customs at the port and the technical control of a Central Officer entitled the Special Chemical Adviser to the Central Board of Revenue. At present, by the courtesy of the Punjab Government, that officer is located temporarily at Lahore where excellent laboratory and library conditions exist. From this Control Laboratory, standard methods of analyses are circulated, investigations are carried out and appeal cases and technical references are submitted for advice or discussion. All laboratories periodically send remnant portions of actual samples for comparative analysis, criticism, information and report. The Indian Customs Tariff is divided into ninety-one general items of which eighty-seven are in the Customs Tariff under twenty-two sections. Samples under more than half of these eighty-seven items can be submitted to the laboratories for test or opinion. When one considers the practically unlimited range of imported articles, a moment's consideration will give an idea the wide scope of chemical knowledge demanded of the Board's chemists if revenue is to be safeguarded. The Special Chemical Adviser visits all the Board's laboratories at least once a year and is in frequent personal contact with the Central Board of Revenue on scientific matters.

In addition to the routine work, the chemists contrive to find time to investigate new methods or modify existing ones in the interests of speed and efficiency and several articles on analytical and other subjects have been published in scientific journals. This phase of activity shows that the chemists take a lively interest in their duties and are anxious to keep in touch with or even in advance of accepted technical procedure. Though the duties of Customs chemists deal mainly with the examination of imported goods in order to allocate them to the correct items of the tariff, the work in the Custom Houses covers a still wider field.

MERCHANDISE MARKS ACT.

From time to time, samples are submitted for test to find out if they are correctly described. Importers of goods which are marked with inaccurate or misleading descriptions are liable to penalties under the Merchandise Marks Act.

For example, bottles of medicine such as quinine, stated on the label to contain a specified amount of the drug, may be found to be deficient in the essential constituent; pen nibs or gold or silver articles may be marked incorrectly as to their composition, *e.g.*, pen nibs may be marked 9 Kt. gold and found to be only gold washed; condensed milk stated to be made from full cream milk may be found to be made from skimmed milk; artificial butter or ghee described as "vegetable product" may be found to contain animal fat or hardened fish oil, etc. A wide range of textile goods and many other articles are submitted for test under this head.

Calcutta is the only laboratory which does Excise work for the Government of India and certain Indian States. A good many samples of fibres such as jute, hemp, sisal, aloe, flax, etc., are also examined for allocation to various items of the Import or Export Tariff.

CONTRABAND.

Another interesting function of the laboratories is the examination of contraband, such as opium and other restricted drugs such as cocaine, known to addicts as "snow", and the testing of certain imports under the Explosives Act or the Dangerous Petroleum Act. Matches are examined for yellow phosphorus and crackers for potassium chlorate and gunpowder.

If contraband opium is found to contain 3 per cent. of its most important alkaloid, morphine, it is sent to the Government Opium Factory at Ghazipur for the manufacture of morphine, codeine, etc., otherwise it is destroyed at the port. Cocaine which is seized by the Customs Preventive staff is kept in bond under an armed guard and a special chemist has been trained to manufacture from the contraband cocaine pure B.P. cocaine hydrochloride which is sold to Government Medical Departments or to other purchasers approved by Government for use in medicine and surgery. The impurities with which the drug is diluted, so that swindling in its illicit sale may be carried on, include synthetic drugs like aspirin and phenacetin and such commonplace substances as starch, Epsom salts or sugar.

SALT.

Originally the analyses of salt samples for the Salt Revenue Department were tested in the laboratories of the Chemical Examiners to local Governments but now all Government salt samples are tested in the Customs Laboratories and, during the non-co-operation movement in 1930, all samples of satyagraha salt were tested in the Board's Control Laboratory—the principal concern of Government being as to whether the

products contained impurities dangerous to human life. Salt is sometimes exempted from duty when used for certain manufacturing processes if it is rendered unfit for human consumption by "denaturing" it with napthalene or "hypo".

Salt imported and issued with the previous sanction of the Governor-General in Council for use in certain manufacturing processes such as glazing stoneware or curing fish is allowed to enter India duty-free.

FUMIGATION.

This extensive country is inflicted with many pests which seriously hinder agriculture and Government is very anxious to prevent the introduction of any new varieties. Hence, all imported living plants and certain seeds have to be disinfected at the ports by fumigation with prussic acid vapour before being sent to their consignees.

TRAINING OF YOUNG CHEMISTS.

From time to time one or other of our laboratories has been responsible for the training of chemists for special purposes and it is now decided that the laboratories of the Central Board of Revenue shall undertake certain testing work for certain other Government Departments, for example, the examination of oils for Indian Railways to enable them to classify them correctly under the various freight rates.

KINDS OF DUTY.

In general, Customs duty can be classified under three heads :—

1. Duty imposed purely for *revenue* purposes. This duty is levied on all goods whatever their country of origin.

2. *Preferential Revenue.*—This is collected for revenue purposes but there is a concession of part of the duty, usually 10 per cent. less for the United Kingdom or a British Colony or both, so as to give privilege to constituent countries of the British Empire. These preferential tariffs which have come into being as a result of the Ottawa Agreement have increased the analytical work because certain imports not previously chemically examined have now to be tested in the laboratory.

3. *Protective Duty* is the duty levied on goods imported into India with a view to safeguarding India's industries. Among these items are cheap printing paper, raw silk and silk waste and textiles containing specified percentages of certain constituents such as cotton, silk, artificial silk, etc., all of which have to be checked by chemical examination.

YARNS AND TEXTILES.

Yarn and textile fabrics yield a considerable amount of Customs duty. In 1930 and 1931, textiles made of artificial silk were assessed at a lower rate of duty than cotton piece-goods. Artificial silk was often substituted for cotton in imported piece-goods. This put Indian cotton manufacturers at a disadvantage, particularly on account of the attractiveness of artificial silk textiles and because artificial silk was not manufactured in India. To protect the Indian cotton industry, the Government of India increased the duty on artificial silk to a rate much higher than that on cotton goods.

Owing to foreign competiton, particularly from Japan, the Government of India has now levied protective duty on all kinds of piece goods and this has materially increased the analytical work as will be understood from the following examples, the classification of all of which depends on chemical examination ; the fibres mainly concerned being cotton, wool, silk and artificial silk and the difficulty of the work is much increased by the introduction of many classes of composite fibres.

Fabrics containing gold or silver thread are assessed at 50 per cent. *ad valorem*, whatever the rest of the material is made of. Fabrics not otherwise specified containing more than 90 per cent. artificial silk are assessable at different rates depending on whether they are or are not of British manufacture.

Woollen fabrics not otherwise specified containing not more than 90 per cent. wool, excluding felt and fabrics made of shoddy and waste wool, made in the United Kingdom are on the preferential list. Their examination involves (*a*) determination of wool and (*b*) the decision as to whether the wool is waste or shoddy.

Other items requiring reports from the laboratories are :—

Cotton fabrics not otherwise specified containing more than 90 per cent. cotton ; fabrics not otherwise specified containing more than 10 per cent. and not more than 90 per cent. silk ; the distinction between pure silk and silk noils and waste silk and many others.

While certain antimalarial alkaloids are imported free of duty, it is difficult to get the same privilege for any substance imported under a trade name for the same benevolent purpose. For instance, Paris Green, a basic arsenite of copper, is used for antimalarial purposes but, as it is employed in other industries, for example, as a pigment, it has to pay duty.

A number of painters' materials are examined, *e.g.*, genuine red lead, genuine white lead and genuine zinc white which have to conform with certain specifications and must be distinguished from the "reduced pigments" or pigments to which a cheaper material has been added to lower the price such as the mixing of barium sulphate with white lead or zinc white. A large variety of pigments are submitted for test including compounds of less common metals like zirconium, tungsten, etc. Manures, chemicals and various technical chemical products often furnish interesting chemical investigations.

MILK AND MILK POWDER.

Condensed milk and milk powders are liable to adulteration and milk products are analysed to find out if the original milk from which the condensed milk or milk powder was made contained the requisite percentage of fat. It is also important to know if other constituents have been removed and complete analyses are sometimes required to ascertain the protein or lactose values of the original milk.

DYES, ETC.

Synthetic dyestuffs made from coal-tar products and coal-tar auxiliaries used in dyeing have been included among dutiable goods. In 1927, as the result of a representation of the cotton mill owners, the Government of India abolished the duty but, in 1932, it was restored and, since then, coal-tar dyes and substances derived from coal-tar used in dyeing processes are assessed to duty at 10 per cent. either *ad valorem* or on different tariff values.

Customs chemists are required to find not only

the class to which a particular dye or auxiliary belongs, but sometimes to identify the substances as well. They are also required to test insoluble dyes, coal-tar lakes and other coal-tar pigments used for the manufacture of printing ink, etc., and which are assessed under a separate heading.

PLATED ARTICLES.

To encourage the electro-plating industry in India, a preferential duty has been imposed on electroplated articles, but the term "electroplating" has caused a good deal of trouble. Ordinarily it means a coating of noble metals like gold or silver on base metals, but there are cheap gold- and silver-washed articles as well as cheap jewellery which cost little and are showy but, on use, rapidly deteriorate and soon show the base metal foundation. The term "electro-plated" signifies articles having a "durable" coating of gold or silver and the criterion of "durability" has often presented difficulties. The words "gilt" or "rolled gold" are often stamped on such goods and the customs chemists are required to test them to detect violations of the Merchandise Marks Act and also to make the difficult decision in border line cases between gold-washed and gold-plated articles.

HYDROCARBONS.

Much work is sent to the laboratories under what may be called " petroleum products " or "hydrocarbons". This includes a wide range of commercial articles, commencing with dangerous petroleum and finishing with tar and other building and road-making materials derived from petroleum or coal. The appraisers also submit a wide range of lubricating oils and greases as well as fuel and kerosene oils and other illuminating oils for examination and report.

PAPER.

An item of the tariff which has caused a great deal of work is printing paper known as "cheap newsprint", containing not less than 70 per cent. of mechanical wood pulp. The other constituents are usually chemical pulp and loading and finishing materials. The analysis is carried out in two ways: (1) optical and (2) chemical. The former depends on the fact that mechanical wood pulp is stained yellow and chemical pulp is stained blue by iodine. The fibres are counted under the microscope. The chemical method depends on the fact that a constituent of mechanical wood pulp combines with phloroglucinol. The well-known method of Cross and Bevan has been standardised to Indian conditions in the Control Laboratory.

Sometime ago, starch could be imported duty free but now it is liable to duty of 15% *ad valorem* while flour or farinaceous food is dutiable at 25% *ad valorem* (except tapioca flour which has a Tariff value and necessitates its distinction in the laboratory from other flours). Since "cornflour" is practically pure starch, one has to decide under which head this has to be assessed. This is a function of the Collector of Customs but presumably he is driven to consider in what manner it is imported; in packets labelled as some sort of foodstuff, or in sacks, presumably for the textile or other industry, possibly to be packeted as a food later on after having paid the lower rate of duty!

Similarly toilet soaps and household soaps are assessed at different rates of duty.

A variety of "toilet preparations" are submitted for test and the high content of liquid paraffin or other mineral oil which occurs in some so-called "pure vegetable oil" hair preparations is surprising.

In these days of artificial products, many essential oils are made up of or synthesised from manufactured constituents and the distinction between the natural and the synthetic oil is one which presents considerable difficulty.

The complexity of the customs chemical work increases daily as the development of synthetic preparations for various industries increases. The identity of these compounds is hidden under non-committal trade names such as Kaffir Plaster, Kasenite, Lactoyd Sheet, Cremol, Ramasit, Pernisol, Purgatol, Asplit, Priemsal, Suma Carb, Ursol, Vimto, Silica sel and sometimes without any name or suggestive description. The composition of these patent preparations cannot be given for obvious reasons but such imports have to be examined in order to advise the Collector of Customs as to which item of the Tariff is involved. About 35,000 samples are examined annually but this gives no idea of the range of the work since, as will be seen from the examples quoted, the examinations are often of a complicated and specialised character.

It not infrequently happens that inter-portal discussions are involved and much investigation undertaken in order to define the category of a particular importation. This can scarcely be avoided owing to the want of precise definitions of many articles of commerce. This difficulty is overcome in various ways, often adopting certain limiting criteria which define the product, but it is clear that those limits must be finally acceptable to the trade before applying them to the material in question.

It will thus be seen that the work of the Customs chemists demands qualified analysts of more than ordinary ability and that Chemical Examiners must have a wide knowledge of the application of the products examined so that, on the one hand, revenue may be safeguarded and, on the other, business interests may get a fair deal.

With the exception of the writer, there are twenty-seven chemists working in the Board's Laboratories, all of whom are Indians and great credit is due to them for their honest and successful work in a difficult and critical field which yearly increases in scope and complexity.

Some Biochemical Factors of Disease Resistance in Plants.

By A. V. Varadaraja Iyengar, D.Sc., A.I.C., A.I.I.Sc.

(*Department of Bio-Chemistry, Indian Institute of Science, Bangalore.*)

THE ability of plants to withstand the effects of extremes of climate or the invasion of parasites is a highly variable quality. Thus, it is common to find a few plants which are able to resist these extraneous influences for considerable lengths of time while others succumb readily. The occurrence of such resistant types has been made use of by botanists, physiologists and plant breeders for diverse purposes. The factors that contribute towards this capacity are of much practical importance and may be classified under the two main heads :—(*a*) morphological or structural, and (*b*) physiological or biochemical.

Our knowledge of disease resistance is derived mainly from animal pathology, in which rapid advances have resulted in the development of immuno-therapy, leading to the protection of individuals from infection. The applications of serum-therapy, chemo-therapy and vaccines are the outcome of researches in the above field. Unfortunately, these procedures do not lend themselves to such fine manipulation with plants as in the case of animals. The reason for this lies in the essential difference between the two groups indicated by Quanjer.[1] Blackman[2] and considered in detail below. In the first place, the nature of immunity itself varies in both the cases. Thus, while acquired immunity plays a large part in protecting animals including human beings from external infection, natural immunity is the most important factor in vegetable life. Secondly, the existence of a circulatory system in animals makes possible the movement of blood to the distant organs, in consequence of which an infection is followed by a general bodily reaction. In plants the lack of such a system is perhaps mainly responsible for the localisation of disease for considerable lengths of time. Again, the existence of this circulatory system in animals has rendered possible the utilisation of serum-therapy technique, whereby immunity acquired at one point is rapidly translocated to different points in the body to control infection. On the other hand, new organs are developing very rapidly in plants and immunity induced artificially at one point cannot be easily transferred to other parts. Even if such a process is conceived of, it is very much inferior to that of animals, and the anti-bodies formed in the older tissues are transmitted only with greatest difficulty to the constantly forming organs. It is obvious, therefore, that serum-therapy cannot be successfully applied to plants. Although this is true to a large extent, more recent investigations by Carbone and Arnaudi,[3] Nobécourt[4] and Chester have made[5] possible the application of vaccination technique in plant protection. In animals, moreover, general bodily reaction is so effective that acquired immunity lasts for considerable length of time, whereas in plants such immunity is not long-standing, and is subject to highly fluctuating external factors such as soil, climate and nutrient supply. Furthermore, while recovery from a disease protects normally an animal from subsequent attacks of the same malady, such recovery in plants does not necessarily immunise them from later invasions of the parasite. Lastly, instances of artificial immunisation of a susceptible plant with a weak or attenuated strain of a known virulent parasite are still rare—a phenomenon which is so successfully applied in the control of animal disease. The recent work of Kunkel[6] indicates the possibility of protecting plants from virus infection such as that of mosaic in tobacco and aucuba by inoculating them with attenuated strains of the infective principle. The effect of these is, however, visible on the plant, such as mottling, etc. Further work is necessary, therefore, to define the conditions of this process.

Nature of disease resistant factors.—The factors that control or modify infection by parasites (including viruses) are mainly two-fold :—(*a*) structural, and (*b*) biochemical. It is futile to separate the two, since the distinction between them is not well defined. It is important, however, to recognise that mechanical or anatomical features play a large part in preventing the parasite from gaining access into the plant tissue, while the physiological condition of the plant determines the establishment of nutritive relations between the host and the parasite. Thus, the plant juice exerts a direct biochemical influence on account of its immediate nutritive value in the early stages of infection. It is possible, therefore, that in some cases, the sap may not be quite suitable for the proper development of a parasite, while in others, the juice may constitute an ideal medium for the vigorous growth and rapid multiplication of the invader. It is sufficient to refer to the work of Zimmermann[7] in this connection. In the process of resisting their entry, plants may exude, by exosmsis. materials which may either hinder or help the regeneration of the disease producing agent. The application of poisonous chemicals externally through dusting and spray treatments is based on the above principle, whereby the poison is made readily available to the organism in the process of feeding on such plants.

Isolation of inhibitory substances.—In Cabbage rot Mallmann and Hemstreet[8] observed a liquefaction and subsequent dissolution of the entire tissue. The extract containing the dissolved material was highly active, even when considerably

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[1] Quanjer, H. M., *Rev. Pathol. Vegetal. de Entom. Agric.*, 1923, **10**, 22.

[2] Blackman, *Brit. Assoc. Rept. Presid. Address to Section K.*, 1924.

[3] Carbone, D., and Arnaudi, C., *L'Immunita Nelle Piante*, Milano, 1930.

[4] Nobécourt, P., *Contribution a' l'etude de l'immunité chez les vegetaux* (Bailliere, Tunis), 1928.

[5] Chester, K. S., *Quart. Rev. Biol.*, 1933, **8**, Nos. 2 and 3.

[6] Kunkel, L. O., *Phytopath.*, 1934, **24**, 437.

[7] Zimmermann, A., *Centl. Bakt. Abt. II.*, 1925, **65**, 311.

[8] Mallmann, W. L., and Hemstreet, C., *J. Agr. Res.*, 1924, **28**, 599.

diluted, in inhibiting the action of the organism producing soft rot. The lytic principle of the extract resembles bacteriophage in this respect that its potency is not diminished by repeated transference of cultures. It will add greatly to our knowledge if further examination of the same is made. A similar principle was isolated by Wagner from plants infected with pathogenic bacteria.[9] Although this was precipitated by protein precipitants, like ammonium sulphate, its exact nature is still obscure.

Individual chemical compounds in relation to disease resistance.—Cook and Taubenhaus observed early that organic acids and tannins inhibited growth of organisms chiefly fungi (?). In their study on the toxicity of tannins, they showed that the capacity of the host plant to resist the entry of parasites was traceable to the presence of certain chemical substances rather than to structural differences. They assumed that tannins were responsible for this, but discovered that the fungi experimented with did not behave uniformly with tannins: some were more susceptible than others. Furthermore, sodium tannate was found to be less potent than tannin itself. It was therefore suggested that although tannins by themselves may not be chemotactic, their reaction would vary in association with and in presence of other substances occurring in plant cells, a view for which no adequate evidence is yet forthcoming. Subsequently, Cook and Wilson[10] confirmed the above observation in their investigation of the chestnut bark blight disease. Cook and Taubenhaus studied also the toxicity of vegetable acids and oxidising enzymes, in relation to fungi,[11] and showed that the development of root rots is traceable to an oxidase which acts on gallic acid in presence of oxygen to produce a tannin-like substance. This capacity diminishes on ripening, thus rendering the mature fruit more susceptible than the tender one.

Walker and his co-workers were the first to correlate resistance to disease with the occurrence of definite chemical entities. According to them, white variety of onions is highly susceptible to *Colletotrichum circinans* (Bark) which causes onion smudge, while yellow and red varieties are quite resistant.[12] In their subsequent studies they detected the presence of protocatechuic acid, *i.e.*, 3, 4, dihydroxy benzoic acid, in the outer scales of the resistant varieties alone. It was noticed that the concentration of this constituent was high in the resistant types, while it was entirely absent or was present only in traces in the white one.[13] These authors further recognised that the amount of the acid isolated may not represent the total concentration of this component. Moreover, the possibility of other compounds also adding to the resistance capacity has not been overlooked by the authors: but since they have noticed a definite correlation between the quantity of acid detected and the degree of pigmentation, *viz.*, the deeper the colour, the greater the amount of protocatechuic acid present, the above findings are of considerable significance. It may be remarked here that this substance is generally found to occur combined in catechol tannins, resins, gums and anthocyan pigments which are normally present in plants. Therefore it will be of great interest to know whether tannins play a part in disease resistance. In virus diseases of plants, including spike of sandal, no such correlation has so far been established. It is, however, of importance to observe that with the onset of spike, diseased leaves are found to contain more tannins,[14] among which the pyrogallol type is more predominant, while in the healthy or unaffected ones the catechol group of tannins is largely present. In a similar way, the colour of the bark shows distinct change to an intense brown colour as the result of spike infection.[15] To what extent, these factors aggravate or modify the insect attack or the visitations of the carrier of infection, is a problem of fundamental importance in the control of this disease.

Reaction of tissue fluid.—Comes first pointed out that the invasion of plants by fungi and other parasites was dependent on the sugar content and controlled by the acidity of the medium,[16] a greater sugar value and a low acidity of the juice being conducive to the rapid multiplication of the organism. He further observed that to this end, sugar and acids occurred in inverse proportions. Thus, low sugar content was correlated with high acidity and *vice versa*. This provides additional evidence to the observations of Cook[17] that the acidity is a natural defence against parasites. Unfortunately, however, the findings of Comes regarding the relation between sugar content and acidity could not subsequently be substantiated by either Mumford in his studies on curly top of beets[18] or, by the author from his investigations on the spike-disease of sandal.[19, 20] It is pertinent here to remark that increased acidity is a favourable condition for the formation of reducing sugars from disaccharides. Comes' observation of inverse relationship between sugar content and acidity is therefore difficult to explain. It may be that both are important factors and act independently.

Wagner studied the relation of reaction of plant juice to attack by parasites. He infected a number of plants with micro-organisms,[21] and observed an initial rise of 0.1 pH followed by a decrease in pH of nearly 0.6 units. Those plants that recovered from the attack reverted to normal and original acidity, while in those that succumbed, another rise was observed followed by a drop in pH when the tissues died. Harvey

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[9] Wagner, R. J., *Centl. Bakt., II., Abt.*, 1916, **44**, 708.

[10] Cook, M. T., and Wilson, G. W., *New Jersey Agric. Expt. Sta. Bull.*, 1916, No. 291.

[11] Cook, M. T., and Taubenhaus, J. J., *Delaware Coll. Agric. Expt. Sta. Bull.* No. 91. 1911.

[12] Walker, J. C., *J. Agr. Res.*, 1925, 30, 175.

[13] Walker *et al.*, *J. Biol. Chem.*, 1929, **81**, 369; **84**, 719.

[14] Varadaraja Iyengar, A. V., *Proc. Eighteenth Indian Sci. Cong.*, 1931, 284.

[15] Varadaraja Iyengar, A. V., (Unpublished).

[16] Comes, O., *Reale Istituto d'Incorraggiaments di Nxapole*, 1916.

[17] Cook, M. T., and Taubenhaus, J. J., *Ibid.*, *Bull.* No. 97, 1912.

[18] Mumford, E. P., *Ann. Appl. Biol.*, 1930, **17**, 35.

[19] Varadaraja Iyengar, A. V., *J. Indian Inst. Sci.*, 1928, **11A**, 93, 103.

[20] Varadaraja Iyengar, A. V., *Ibid.*, 1929, **12A**, 295.

[21] Wagner, R. J., *Ibid.*, 1915, **42**, 613.

noticed a similar condition.[22] On the other hand, Hurd[23] could not correlate acidity in wheat, with resistance to disease. In sandal spike, the author (*loc. cit.*) observed that with the onset of disease, the reaction of leaf tissue fluid turns slightly more alkaline than that of the corresponding healthy ones but became more acidic with the advance of the disease. No apparent relation could be traced between sandal plants growing with different hosts. It may be concluded that acidity is not an important factor in the resistance of sandal to spike. Mumford examined beets which were susceptible or resistant to curly top. He could not detect any difference in the initial reaction of the juices of the two varieties.[24] Moreover, he found a greater concentration of total sap and of reducing sugars in the susceptible variety. This is however not in agreement with the observations of Carter, according to whom, the beet leaf hopper, *Euttettix tenella* Baker, which transmits this disease does not feed on plants which have a high sap concentration and this was used as an indication of resistance in beets.[25] The present author observed that in the advanced stages of spike a low pH value[19] is accompanied by the exclusive presence of succinic acid and by a characteristic diminution in oxalic acid.[26] Soluble sugars are also present in large quantities. In incipient stages, on the other hand, hydroxy acids are more prominent. These changes would appear to be traceable to the limited availability of calcium consequent on infection. The significance of these observations will be considered elsewhere.[27] Reynolds noticed that the growth of *Fusarium Lini* was depressed in an extract from wilt resistant flax, while in that of a susceptible one, it developed rapidly. The nature of the principle is still undetermined though evidences point to its glucosidic nature.[28]

It is well recognised that wild varieties of different species are more resistant to infection than cultivated ones. The factors involved in this are still obscure. Campbell[29] sought to induce immunity in cultivated applies to *Oïdium farinosum* and to certain insects, through extra-radicate injection of weak solutions of tartaric, citric and malic acids. A similar treatment of sandal with malic acid prior to artificial infection through grafting did not impart any resistance to such plants.

Where acidity could not be correlated with immunity, attempts have been made to explain resistance to disease as being due to buffers occurring in plant saps. Ingold[30] could not, however, establish any relation between immunity and buffer index values in potato. Failure to tracing disease-resisting factors to initial acidity or to buffer values of the juice is due to the fact that these studies have been made on the expressed sap which may not represent the fluid actually present within the cells. Though spike disease induces abnormal changes in the buffering processes of sandal, Srinivasan and Sreenivasaya were unable to trace any striking difference in the buffers of sandal, grown in pots in association with different host plants.[31] It is difficult to reconcile this with Sreenivasa Rau's observation that the host plant associated with sandal determines the composition of the parasite.[32] Obviously factors like age, environmental factors play considerable part in the metabolic activities of sandal.

Enzymes in relation to disease resistance.—Though considerable amount of work has been reported on the enzyme content of plants as affected by disease in plants, no investigation has been conducted in relation to immunity to disease. Recently Suchorukov[33] found that peroxidase action was related to resistance to rust in *Helianthus annus*, *Artemisia* and *Xanthium* being lowest in the immune parts and individuals. On the other hand, catalase and proteoclastic enzymes were not found to play any part in the establishment of immunity. Alteration of the soil acidity affects peroxidase activity in the roots of sunflowers, the greatest depression of activity being observed in neutral soils. The presence of antioxidases or oxidase inhibitors could not be detected. Klotz observed that resistance to diseases was correlated with an inhibitory effect of the bark on certain enzymes produced by the fungi and suggested that similar inhibition of fungous enzymes by plant tissues might explain how certain plants resist the invasion of microorganisms.[34] Since the relation of enzymes to disease resistance has still remained obscure, it will greatly add to our present knowledge if well known resistant types of plants are examined for their biochemical activities as compared with the highly susceptible ones.

Disease susceptibility and nutritional factors.—A large number of cases are known where it has not been possible to trace resistance to definite nutritive factors. On the other hand, striking evidence has been adduced to correlate nutritional deficit with the occurrence of disease. Further, as many plant diseases, particularly those of virus nature, are transmitted in nature through the agency of insects, the factors that determine insect attack should be of more practical importance. Spinks[35] drew attention to the fact that susceptibility to both mildew and rust in wheat as also to mildew in barley was enhanced by the availability of large quantities of nitrogen while application of potash showed a contrary effect. Plants which were semi-starved of nitrogen appeared to exhibit some immunity as also those to which lithium salts were applied. Lead and zinc salts did not appear to confer immunity. He thus established for the first time some

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[22] Harvey, R. B., *J. Biol. Chem.*, 1920, **42**, 397.
[23] Hurd, A. M., *J. Agr. Res.*, 1924, **27**, 725.
[24] Mumford, E. P., *Nature*, 1930, **125**, 411.
[25] Carter, W., *Ecology*, 1927, **8**, 350.
[26] Varadaraja Iyengar, *J. Indian Inst. Sci.*, 1933, **16A**, pt. XIII.
[27] Varadaraja Iyengar, A. V., *J. Indian Inst. Sci.*, 1934, **17A**, pt. XII.
[28] Reynolds, E. S., *Ann. Mo. Bot. Gardens*, 1931, **18**, 57.
[29] Campbell, C., *Rend. R. Acc. Lincei.*, 1918, **5**, 57.
[30] Ingold, C. T., quoted by Small, J., "H-ion conc. in plant cells and tissues.—Protoplasma monograph No. II," 1929.
[31] Srinivasan, M., and Sreenivasaya, M., *J. Indian Inst. Sci.*, 1934, **17A**, pt. 13.
[32] Srinivasa Rau, Y. V., *J. Ind. Inst. Sci.*, 1933, **16 A.**
[33] Suchorukov, K., *Z. Opytn. Agron. Jugo-Vostoka*, 1930, **8**, 237.
[34] Klotz, *Science*, 1927, **66**, 631.
[35] Spinks, G. T., *J. Agr. Sci.*, 1912–13, **5**, 231.

chemical factors which determine susceptibility to disease in plants.

Subsequently Lees showed that water content of plants determines their relative susceptibility to insect pests.[36] According to him, several cases were noticed wherein insect attack was evident due to profuse irrigation or following heavy rainfall, it appears probable, however, that it may actually be a case of physiological drought due to defective soil aeration in spite of such large supply of water. In an earlier publication[37] Lees had shown that water and nitrogen contents were interdependent. A defective root system has invariably been recorded in diseased plants including virus infected ones. It is of great importance to correlate water balance as a factor of resistance to insect attack. Thus, it has been shown by Mumford that a disturbed water content rendered the cotton plant more susceptible to sap feeding insect pests.[24] A similar condition has been observed with sugarcane also: plants suffering from water shortage were found to be more attractive to the attacking thrips than those receiving the normal supply. Recently Mumford has analysed the different factors[38] and has classified them as being due to (*a*) morphological adaptations and (*b*) biochemical factors. The former may include, among others, the formation of thickened epidermis or cuticle or the development of hairs. In the latter case, the action may be due to some condition of the cell sap which will help to repel the invasion of insects or to the presence of substances such as certain essential oils, alkaloids or organic acids or that the composition of the sap may be so altered as to be quite unsuited to insects for their food requirements. The problem is highly complicated that a detailed study is necessary before any definite conclusion can be drawn. Carter has shown that an extremely high sap concentrations in beets are undesirable to and avoided by the sugar beet leaf-hopper, the carrier of curly top of beets, if more suitable food is available in the neighbourhood.[25] Mumford could not observe any marked difference between the varieties which are resistant and those which are susceptible to this disease. Similarly, Srinivasan and Sreenivasaya (*loc. cit.*) could not find any significant changes in the acidity of sandal grown in association with host plants which render the parasite highly susceptible to spike infection. It would appear that in this particular instance, lime is the chief predisposing factor and makes sandal highly prone to the disease since the calcium content of a plant is very high before it manifests symptoms of spike but shows a striking decrease with the onset of disease. Preliminary study on the rôle of lime on the apparent ease with which infection can be artificially transmitted to plants has indicated the harmful effect of this constituent in relation to disease transference.[27] Further evidence is adduced from the observations in diseased localities where application of lime to apparently healthy plants has not minimised the rate of spread of disease in them: in fact, it is significantly high in those cases. This is in conformity with the observation of Laurent[39] according to whom lime renders plants susceptible to diseases.

It will be clear from this short survey that no systematic study appears to have so far been carried out, of the biochemical factors of disease resistance in plants. The only entities that have been considered of any significance by the plant pathologist are the vegetable acids and tannins. Even here our knowledge is inadequate and much more yet remains to be done. It will be of great interest to know how these defensive mechanisms are brought about and the agency responsible for the same. It appears that the respiratory process as measured by the different oxidative activities, such as oxidases, peroxidases and catalase will throw considerable light on the subject. This is particularly so since acids arise also during respiration of the cell and tannins appear to enormously influence their action. Another useful line of inquiry may be directed towards the presence of certain rare minerals which modify the metabolic activities in a strikingly remarkable manner. The biochemical adaptations induced in plants, in consequence, would help to elucidate, many unknown and at present inexplicable phenomena. Certain experiments of a purely preliminary character, carried out by the author, indicated the possibility of employing such elements below their toxic concentration, to immunise plants against plant pathogens. Again, the feasibility of inactivating the causative agent, particularly a virus present in a diseased tissue without destroying the latter by suitable and careful administration of sublethal doses of plant poisons such as copper, arsenic, was tried in the case of spike[27] but could not be pursued further for diverse reasons. Lastly, a study of the mechanism by which certain constituents like water, nitrogen, etc., render plants highly susceptible to infection, will add vastly to our existing knowledge and will indirectly explain the process by which the attacked organism overcomes successfully the marauders of the invader.

[36] Lees, A. H., *Ann. Appl. Biol.*, 1926, **13**, 506.
[37] Lees, A. H., *Ibid.*, 1923, **10**, 35.
[38] Mumford, E. P., *Science*, 1931, **73**, 49.
[39] Laurent, E., *Ann. Inst. Pasteur*, 1899, **13**.

A Short Report on the Economic Value of *Artemisia* growing in the North-West Frontier Province.

By N. A. Qazilbash,
Professor of Botany, Islamia College, Peshawar.

ARTEMISIA is very common in the North-West Frontier Province. Successful investigation of the Kurram *Artemisia* for the manufacture of santonin inspired great hopes of finding out additional sources of santonin in other parts of the country, where *Artemisia* resembling very much the Kurram material in appearance, grows in great abundance. It was therefore considered absolutely essential to carry out a thorough examination of the available material in these localities with a view to determining its economic value definitely. On the recommendation of Lt.-Col. E. W. C. Noel, C.I.E., D.S.O., the Director of Agriculture and Allied Departments, North-West Frontier Province, facilities were provided by the local Government for investigating promising regions in Waziristan, Tirah, Khyber and Malakand Agencies. Specimens and samples were collected from different localities at different times. The specimens were studied botanically and the samples were examined chemically for their santonin contents. The results of the findings are briefly mentioned below :—

(i) *Tirah, Khyber and Dir.*—*Artemisia maritima* grows in great abundance in the areas under review. It is very much similar to the santonin-containing *Artemisia* of the Kurram Valley in appearance but differs from it considerably in diagnostic characters. The full details of these characters will appear later. Samples were collected from different localities at intervals of a fortnight. They were examined for their santonin contents. Careful examination showed that the available material in these areas is commercially of no value as it contains no santonin.

(ii) *Waziristan.*—In South Waziristan, *Artemisia* is very abundant in the Wana plains, but the material in question is of no commercial value as it is without santonin.

In North Waziristan, *Artemisia maritima* is found at Datta Khel, Tut Narai, Shirina and Kazi. The areas in question are very small but the plant material growing in these areas contains a very good percentage of santonin. Samples collected during the end of September showed an average of 1·2 per cent. santonin.

(iii) *Chitral.*—*Artemisia* grows very abundantly throughout the country and forms a conspicuous feature of the indigenous flora. There are several species, the principal ones being :—(*a*) *Artemisia sacrorum* ; locally known as "Pispuk". (*b*) *A. scoparia* ; locally known as "Zia". (*c*) *A. laciniata* ; locally known as "Gudraun". (*d*) *A. Thomsoniana* ; locally known as "Daraun". (*e*) *A. maritima* ; locally known as "Maizini Daraun".

The chemical examination of several samples of each of *A. sacrorum*, *A. scoparia*, *A. laciniata* and *A. Thomsoniana* from different regions collected at different times of the growing period, showed that they do not contain any santonin.

Artemisia maritima collected from Drosh and its neighbourhood gave positive results, but the percentage of santonin is very low and is therefore not of much commercial value. It is, however, noteworthy in this connection that the samples submitted to chemical examination were not collected at the time when the plant contains the maximum amount of santonin. If the collections are made at the proper time, the percentage of santonin is very likely to show an increase.

The regions lying beyond Shaghour Valley on the East side could not be visited last year. The question of the economic value of *Artemisia* species growing there could not be taken up for want of time at the disposal of the writer. These regions have ecological conditions suitable for the occurrence of santonin-containing species of *Artemisia* such as *Artemisia brevifolia*, which grows abundantly in Kashmir and which, in certain selected areas, especially shows a good percentage of santonin. It is therefore very much desirable to carry on further investigations in this direction. This might ultimately lead to finding out species of *Artemisia* with a good percentage of santonin and establishing a permanent source of revenue for the Chitral State. A suitable area could then be selected for the cultivation and extension of the most desirable varieties of *Artemisia* for commercial purposes.

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[1] Clarke, C. B., *Compositeæ Indicae.*

[2] Duthie, J. F., *Records of the Botanical Survey of India*, Calcutta, 1898, **1**, No. 9.

[3] Qazilbash, N. A., *Bulletin des Sciences Pharmacologiques*, March 1935, No. 3.

Lady Tata Memorial Scholarships.

THE Trustees of the Lady Tata Memorial Fund announce that on the recommendation of the Scientific Advisory Committee they have made the following awards of scholarships and grants for the academic year 1935-36. These awards are open to suitably qualified persons of any nationality for research work in diseases of the blood with special reference to leucæmia. Scholarships: Dr. M. C. G. Israëls (Manchester), Dr. O. Kaalund-Jörgensen (Aarhus). Grants: Prof. W. Büngeler (Danzig), Dr. J. Engelberth-Holm (Copenhagen), Dr. Karl Hinsberg (Berlin), Dr. Ch. Oberling (Paris), Prof. Eugene Opie (New York), Dr. Lucy Wills (London).

"Discovery II" and The Exploration of the Whale's Habitat.

THE Royal Research ship "*Discovery II*" returned from Antarctic on June 3rd after completing her third commission. The expedition was of 20 months' duration and covered 2 arctic summers. The scientific work was in charge of Dr. N. A. Mackintosh with Mr. H. F. P. Herdman as Chief Hydrologist and Lieutenant A. L. Nelson, R.N.R. in executive command.

The ship left Thames on October 21st, 1933, and 5 weeks later (Nov. 21st) was on the whaling grounds of South Georgia. After a few days' stop there, she left Georgia and a line of stations was then made across the Scotia sea to the South Shetlands and from there due north to the western opening of the Straits of Magellan. A number of observations was made with the primary object of following the seasonal changes in the water movements and so trace the circulation of the marine animals and plants, on which the whales and all other antarctic life are ultimately dependent. Thirty full stations were made during the cruise and in addition 19 subsidiary "towing" stations. A full station takes 3 to 4 hours; it includes a sounding and noting of meteorological data; of chief importance are the observations of sea temperatures taken at, at least 20 points between the surface and the bottom—here from 2½ to 3 miles deep—and of the collection of water for chemical analysis from the same points. Concurrently, a series of hauls are made, both vertically and horizontally with nets of varying mesh; those of the finest—200 meshes to the linear inch—are designed to collect the microscopic vegetation, which constitutes the "pastures" of the ocean, and is as important at sea as on land; those of the medium mesh are for the smaller forms of animal life, including young stages of whale food; and the largest, for the adult whale food, a prawn some 2½ in. in length—the so called "krill" which forms the only food of the rorquals. A "towing" station is confined to using certain of the nets to keep a check on the intervals between stations, as the distribution of animal and plant life is sometimes "patchy".

"*Discovery II*" returned to South Georgia on April 10th and on her way back repeated the series of stations already gone through. The second season was begun under winter conditions and after traversing the East Pacific Sector and making some important observations, was back at South Georgia on January 27th, 1935. On her return journey, she communicated with a whale marker "*William Scoresly*" which was also working towards the same objective as "*Discovery II*". While the latter was exploring the whales' habitat and the life-history of its food supply, "*William Scoresly*" is interested in marking the whales in order to know whence and where they travel, at what speed and in what numbers.

"*Discovery II*" is to leave London again in the course of the next autumn on her fourth and probably final commission.—(*From an article in 'Statesman', June 18th.*)

Research Notes.

Can Quantum-Mechanical Description of Physical Reality be considered Complete?

ON the basis of the uncertainty principle arising from Quantum Mechanics, the philosophical outlook of modern science has been asserted to be one of indeterminism and the principle of causality has been repudiated by such scientists as Bohr, Heisenberg, Weyl, Eddington and Jeans. On the other hand Einstein, Planck, Rutherford and Silberstein are staunch adherents to the view that the principle of causality still rules Physical Science. In view of this divergence of opinion, a paper with the above title by Einstein, Podolsky and Rosen (*Phys. Rev.*, 1935, **47**, 777) requires careful consideration. In this paper the authors observe that any physical theory which attempts to explain the objective world must satisfy two conditions, *viz.*, that it must be true and that the description given by the theory should be complete. They formulate the condition of completeness in the following terms: "Every element of the physical reality must have a counterpart in the physical theory." They define a physical reality by postulating that "if, without in any way disturbing a system, we can predict with certainty (*i.e.*, with probability equal to unity) the value of a physical quantity, then there exists an element of physical reality corresponding to this physical quantity." This they consider not as a necessary but only a sufficient criterion of reality. Translating this condition into the language of quantum mechanics they show that in the case of particle with a single degree of freedom its momentum satisfies the condition of reality while its co-ordinate of position does not satisfy that condition. There are now two alternatives: (1) either the description of reality given by quantum mechanics is not complete, or (2) when the operators corresponding to two physical quantities do not commute the two quantities cannot have simultaneous reality. The assumption so far has been that the description given by quantum mechanics is complete so that the second alternative was chosen. The authors now show, however, that this assumption leads

to a contradiction when considered along with the criterion of reality, by proving that two physical quantities with non-commuting operators can have reality. Hence they conclude that the description provided by quantum mechanics is not complete, but express their conviction that some other complete theory is *possible.*

T. S. S.

The Nuclear Spins and Magnetic Moments of the Principal Isotopes of Potassium.

IN the *Physical Review*, 1935, **47**, 739, S. Millman reports the result of his experiments in which the spins and magnetic moments of K_{39} and K_{41} were investigated by the method of magnetic deflection of molecular beams developed by Breit and Rabi. An analysis of the curves led to the value $I=3/2$ for K_{39} and the value of the separation $\Delta\nu$ of the $^2S_{1/2}$ state was thence calculated to be $0 \cdot 0152 \pm 0 \cdot 0006$ cm.$^{-1}$. This result is interesting because it is only recently that the experimental difficulties involved in the measurement of this small separation have been ingeniously overcome by Jackson and Kuhn (*Proc. Roy. Soc.*, A, 1935, **148**, 335), who also obtain a value $\Delta\nu=0 \cdot 0152$ cm.$^{-1}$ They observed the absorption due to a molecular beam moving perpendicular to the direction of observation so that the Doppler broadening was prevented and were thus able to resolve the line. They were unable, however, to fix the value of the nuclear spin definitely, but the work of Millman solves the problem without ambiguity and the magnetic moment of the K_{39} nucleus is then calculated to be 0·39 nuclear magnetons. In the case of K_{41}, it is only concluded that $I > \frac{1}{2}$ and that the ratio of the magnetic moments of K_{41} and K_{39} is such that

$$0 \cdot 42 < \frac{\mu_{K41}}{\mu_{K39}} < 0 \cdot 88.$$

T. S. S.

The Structure of Hydrogen Peroxide.

ON the basis of the value for the dipole moment of the molecule, Theilacker [*Zeit. Physikal Chem.*, (B) 1933, **20**, 142] suggested that in hydrogen peroxide there is a free notation of the two OH groups about the O—O bond as the axis. Penney and Sutherland (*J. Chem. Physics*, 1934, **2**, 492) however concluded from wave-mechanical considerations that the two OH groups are not in free rotation, but fixed at an azimuth of 90°. This structure will also agree with the observed moment value. A. Simon and F. Fehér (*Zeit. Electrochem.*, 1935, **41**, 2291) have now studied the Raman spectrum of 99·5 per cent. hydrogen peroxide and find strong evidence for the structure proposed by Penney and Sutherland. Besides a strong line at 877 cm.$^{-1}$(15) due to O—O oscillation, there are two bands at 1462-1345 (1) and 3410-3200 (3). The latter is the well-known water band due to O—H oscillations. The band at 1462-1345 is a deformation band correponding to the 1648 band of water, and shows two clear maxima corresponding to the two kinds of closely allied deformation oscillations to be expected from the wave-mechanical structure. The absence of free rotation is supported by the fact that there is no doubling of the frequencies O—O and O—H.

The Interaction of Atoms and Molecules with Solid Surfaces.

THE activity of atoms and molecules on solid surfaces is an important problem connected with chemical reactions taking place on solid surfaces. The atoms and molecules may vibrate about a mean position or may migrate from one part of the surface to the other, or may be ejected from the surface altogether, by the thermal agitation of the solid surface beneath them. The problem has been investigated by J. E. Lennard-Jones and C. Strachan [*Proc. Roy. Soc.*, (A), Vol. 150, p. 442] who have worked out formulæ for the mean interval between successive excitations from the lowest vibrational state to higher states and also for the mean time during which the atom remains in an excited state. In the following paper, C. Strachan has examined the process of evaporation of absorbed atoms or molecules on a surface.

A Relation between Molecular Spectra and Constituent Electrons.

H. DESLANDRES has traced a very interesting relation between the vibration spectrum of a molecule and its constituent electrons by means of an empirical formula. The formula is given by $\nu=qd_1/r's'$, where ν is the frequency of vibration in wave-numbers, d_1 is an universal constant having the value 1062·5, s' is the number of electrons in the outer ring or rings of the constituent atoms of the molecule, q is an integer and r' is

another integer usually small. His papers in the *Comptes Rendus* (Paris, 1934-35) contain many experimental proofs of his formula.

Adsorption and Catalysis.

THE mechanism of the adsorption of reacting molecules on a surface in relation to catalytic activity is of considerable interest and has been tackled by a number of workers. It is well known that contact catalysis proceeds from strong adsorption which in turn is due to ionisation of atoms or molecules caused by the surface. A hot filament of Tungsten, Iron, Molybdenum or Platinum placed in vapours of Potassium captures the valence electrons and adsorbs the Potassium ions so formed. Nyrop has developed recently (*J. Phy. Chem.*, 1935, **39**, 643) the ionisation mechanism for the catalytic activity of surfaces. He has formulated two postulates for the same: (*a*) The catalytic surface is at the temperature in question, able to ionise such of the molecules among the reactants as are most difficult to ionise; and the surface will cause a strong adsorption, as the ions formed are attracted by the surface. (*b*) Other conditions remaining the same, a molecule with a lower ionisation potential is adsorbed in preference to one with a higher ionisation potential. The ability to cause ionisation can be represented by an electric field at the surface, the potential barrier hindering the free electrons of the metal from escaping. The energies of activation for the adsorption of a given molecule on surfaces will determine the relative catalytic efficiencies of the different substances. The type of ionic adsorption pictured by Nyrop does not involve assumptions regarding "Peaks" on surfaces, formulated by Taylor. When ionic adsorption takes place, the positive ions formed by ionisation weakens the field due to the surface electrons. Catalytic poisons would, according to this theory, consist of those substances whose ionisation potential is low. Catalysts with high ionising power are more easily poisoned than others with lower ionising power. A too narrow potential barrier in relation to the dimensions of the adsorbed molecule may weaken the power of ionisation. When molecules coming into contact with the surface are highly unsaturated, they are adsorbed at two or more points. The preferential adsorption of highly unsaturated molecules is the cause of preferential hydrogenation of unsaturated organic compounds. The above theory developed by Nyrop may be of use in the elucidation of the numerous problems that arise in contact catalysis.

M. P. V.

The "Transition State" Concept in the Interpretation of Reaction Velocities.

ACCORDING to the kinetic theory chemical reactions ought to proceed at extremely high speed, if every collision between the reactants is effective in bringing about a chemical change. The occurrence of numerous chemical reactions which proceed at measurable rates can only be explained by postulating an energy barrier between the initial and final states. The condition of the reacting system at the top of the barrier is designated the transition state. It is well known that the *energy* of the transition state for any reaction can be calculated from the temperature coefficient of the velocity constant. Similarly it should be possible to estimate the *density* of the transition state from the pressure dependence of the specific reaction rate. M. G. Evans and M. Polanyi (*Trans. Far. Soc.*, 1935, **169**, 877) have outlined a general theoretical treatment of the reaction velocities by the transition state method and have applied it to interpret the variations in velocity constants of reactions at high pressures. They are thereby able to account for the exponential dependence of reaction velocity on pressure. They also explain the strong acceleration brought about by pressure in the case of many of the so-called "slow" reactions. It is often surmised that reactions accompanied by a diminution in volume should be accelerated by pressure. The theory detailed in this paper, however, shows that this can only be true if the density of the transition state is intermediate between that of the initial and the final states. The *cis-trans* isomerisation of fumaric acid is not accelerated by pressure though the reaction is accompanied by a diminution in volume. The transition state appears in this case to be one having a lower density than either the initial or the final state. The ideas set forth in this paper, besides their theoretical interest, seem to be of value in the investigation of high pressure reactions of technological importance.

K. S. G. D.

Effect of Cathode Rays on Hydrophobic Sols.

THE literature on the effect of ionizing radiations on colloids is one of conflicting results due to large effects of impurities, sensitiveness to hydrogen-ion concentration and other unknown factors such as internal photo-electric action. May Annets (*J. Phys. Chem.*, 1935, **509**, 39) has investigated the effect of cathode rays on sols of copper, gold, silver, lead, bismuth, platinum, ferric hydroxide and arsenious sulphide. The stability of both positively and negatively charged sols is found to decrease. This is to be expected; the cathode rays on collision with the sols give up their kinetic energy and their charge. With the gain of the charge the stability of the sol will increase or decrease as the sol is negatively or positively charged. The kinetic energy produces ionisation of the dispersion medium and thereby the increase of electrolytic concentration, which in general decreases sol stability irrespective of the sign of the charge. In the absence of a permanent chemical reaction the positive and negative ions recombine with production of heat.

Under cathode ray bombardment the rate of heating of the sol was found to be definitely greater than the rate of heating of water, a phenomenon which is yet to receive an adequate explanation. The accepted heats of flocculation, the energy due to the charge on the surface of the colloid particles and the energy due to the compression of the water around the colloid particles being too small by 10^3, 10^6, 10^{13} times respectively, to account for the observed difference, it is not clear what additional source of energy in the colloid state could account for this phenomenon.

K. S. R.

Starches from Old and New Rice.

THE difference in the physical properties and in the behaviour under various treatments of starch from old and new rice forms the subject of a study by D. L. Sahasrabuddhe and M. M. Kibe and is reported in the *Indian Journal of Agricultural Science*, Vol. V, Part I. Coarse rices, reported to be fit only for bread making as distinguished from the finer ones fit for use as boiled rice, are composed of larger grains, but all are alike in general appearance with the usual characteristic polygonal shape. In one and the same variety, old and new grains show no difference in size. In their behaviour towards methylene blue and iodine, no difference in the starch of different varieties or of different ages was noticeable. Older rices and those of the finer cooking varieties soften more than do new rices and those of the coarser bread varieties, when treated with boiling water and with dilute caustic soda. Likewise as an indication of the extent of digestibility, it is brought out that the hydrolysing action of hydrochloric acid, diastase and pancreatin was more on old rices than on new rices, the same behaviour differentiating also the finer rices from the coarser ones, except in regard to pancreatin. The rices also show significant difference in the amount of liquefaction of the starches on boiling with water, the older liquefying much more than the newer ones and hence being more readily digested. The presence of an amylo-hydrolytic enzyme in the rice grain is established, the prolonged action of which on rice in storage may account for the greater susceptibility of older rices to the various treatments described.

A. K. Y.

Treatment of Opium Habit with Lecithin.

A VERY important contribution towards treatment of opium addiction has been made by Wen-chao-Ma and co-workers at the suggestion of Dr. J. Heng Liu, Chairman of the National Opium Suppression Commission, China. (*F. E. A. T. M.*, Nanking, 1934, Vol. II, 381–387.)

The authors observed that opium smokers can secure comfortable and spontaneous cure by means of lecithin diet. A daily dose of 60–90 gm. of lecithin from Soya bean took from 3 to 6 weeks and sometimes more to break the habit. Soya bean lecithin was found to have advantage over egg yolk preparation in that it is less expensive and is said to be more easily assimilated.

Lecithin does not have the property of directly suppressing the symptom. It has been observed that in serious cases of opium addiction, the amount of lipoid material in the body cell is reduced to nil, while in moderate cases there exists a fair amount and in light cases a relatively big amount. When lecithin is administered orally, the lipoid material is gradually increased with the external manifestation of corresponding subsidence of the craving symptom and an amelioration of the opium habit. The patients treated with lecithin diet had no

disturbance in bowel movement, their appetite was good and they increased in body weight. They enjoyed a sound sleep and felt happy throughout the treatment.

According to the authors, lecithin treatment affords a means of suppressing opium habit without the use of military force or elaborate hospital equipment.

N. C. D.

Transmissibility of Tobacco Mosaic Virus by Aphids.

It being fairly well established that heavy infections with tobacco mosaic in tobacco fields are not attributable to the dissemination of the virus by aphids from tobacco to tobacco, the possibility of transmission by aphid agency of the virus from other host plants is investigated by Isme A. Hoggan (*J. of Agr. Research*, Vol. 49, No. 12). Out of the eighteen hosts tested, transmission was obtained only from the tomato, occasional infections developed in eight and no infection at all from the others. The positive results were however rather insignificant, as only one aphid out of 129 caused infection even in the best of the three species of aphids used as carriers. It is concluded that it is unlikely that any appreciable amount of dissemination of tobacco mosaic is brought about by aphids, except perhaps from the tomato.

The Relation of Plant Characters to Yield in Sorghum.

Correlation studies of eight different plant characters as related to yield of grain per plant in respect of two irrigated and three rain-fed varieties of sorghum, carried out over a series of two seasons in Coimbatore by G. N. Rangaswamy Ayyangar and his assistants, bring out certain characters as reliable indices in selecting for high yield (*The Indian Journal of Agricultural Science*, Vol. V, Part I). The diameter of peduncle, weight, length and thickness of earhead and straw weight have given high positive correlation values. The weight of 100 grains has given high correlation values in the case of the irrigated varieties and low values in the case of the rain-fed varieties. The length of peduncle is either not correlated or is negatively correlated with yield. In the two irrigated varieties, the duration of the crop was also studied and was found to be negatively correlated with yield. A review of the previous work on the subject both in India and outside is also given, the conclusions of the authors being in general agreement with those of the workers in Bombay for all the characters common to both the studies.

A. K. Y.

A Further Note on the Feeding Mechanism of *Chirocephalus diaphanus*.

H. G. Cannon in the above paper (*Proc. Roy. Soc. Lond.*, B, 1935, **806**, 455) describes the feeding mechanism of *Chirocephalus* and largely agrees with the description given for *Anostraca* by Eriksson (*Zool. Bidr. Uppsala*, 1934, Vol. 15, p. 23). There are, however, two important points in which Cannon differs from the latter author and they are (1) the method of production of the oral food current, and (2) the function of the labral gland. According to Eriksson, the current is a continuous stream while Cannon maintains that it is an intermittent one. As regards the labral gland, Eriksson believes that the secretion of the gland agglutinates the extra food matter to be thrown away, while Cannon is of opinion that the glandular secretion is helpful in aiding *Chirocephalus* in binding the food to be eaten. Moreover, the author has been able to show by suitable staining, the existence of an anteriorly-directed food current. With regard to the labral gland secretion he notes that "a part of it oozes round the sides of the labrum and forms a mass underneath the head region and mouth, while a part of the secretion passes backwards beyond the tip of the labrum where it is sucked against the inner surface of the anterior trunk limbs." Here it converts the anteriorly–directed food current into a groove.

Origin and Nature of Nucleolus.

Mary S. Gardiner (*Quart. J. Micro. Sci.*, 1935, **77**, 308) has examined the structure and behaviour of the nucleolus in a number of plants and animals. Using Feulgen's technique, the author has come to the conclusion that the nucleolus is not chromatinic and that it is albuminoid in chemical composition, probably closely allied to "formed yolk". Its significance in regard to secretory activity of the cell is considerable and is by no means an accumulation of waste matter. Its absence in cells where there is

no secretory activity like the oogonia and spermatogonia and spermatocytes of *Limulus* and *Tenebrio* points to a definite correlation between the nucleolus and secretory activity of the cell. And the transformation it undergoes during the process of vitellogenesis when it becomes vacuolated and finally disappears also points to the same conclusion. Cells of most plant tissues are to be considered secretory and the universal presence of a nucleolus in these cells emphasises this idea.

The Autonomic Nervous System of *Amphioxus*.

PROF. J. BOEK'S paper (*Quart. J. Micro. Sci.*, 1935, **77**, 308) describes the enteric nervous system of *Amphioxus lanceolatus*. *Amphioxus* has been often denied a sympathetic nervous system comparable with that of higher vertebrates. The author has, however, found in the walls of the intestine a nerve plexus comparable with the plexus of Auerbach of higher vertebrates and a more delicate nerve plexus analogous to that of Meissner is also reported. The ganglion cells and their synaptic connections with pre- and post-ganglionic nerve fibres all recall the sympathetic system of higher vertebrates. The entire plexus is connected with the central nervous system by visceral nerves and dorsal roots.

Relations of Anorthosite to Granite.

IN connection with the sixteenth International Geological Congress, a very instructive excursion was conducted to the well-known anorthosite areas of Adirondacks and Duluth. A comparison of the rock types from the above areas has been made by F. F. Grout and W. W. Langley (*Journal of Geology*, Vol. XLIII, No. 2). The difference between the two is due to the intense deformation of the Adirondack rocks, during or after crystallisation developing granulation and showing minerals and structures characteristic of metamorphic rocks. At Duluth the rocks have suffered little or no deformation and therefore in common with other anorthosite areas, the granitic phase of the magma seems to have evolved from gabbro magma sometime after the anorthosite was formed. After a very careful study of these rocks both in the field and in the laboratory they have suggested that both the granite and the anorthosite are related to gabbro, but not differentiated directly from each other.

The Vitamin A Content of Certain Sweet Potato Varieties.

VERY marked differences in the Vitamin A content of different varieties of the sweet potato (*Ipomœa batatas*) are disclosed as the result of a study of five varieties commonly grown in Tennessee (*J. of Agr. Research*, Vol. 50, No. 2) by F. L. MacLeod and his students. The differences were of the following order, *viz.*, 13,500 units, 900 units, 1,800 units, 9,000 units and 4,500 units per pound respectively by the varieties Nancy, Hall, Triumph, Southern Queen, Porto Rico and Yellow Jersey. It is also brought out that the Vitamin A content materially increases by the storage of the potatoes for two months or more, the Porto Rico increasing from 9,000 to 29,000 units and the Yellow Jersey from 4,500 to 18,000 units by this process. The observation made in previous work that the Vitamin A content increases with the depth of pigmentation of the varieties is also confirmed.

A. K. Y.

Crystalline Insulin.

BY their new method of crystallisation of insulin hydrochloride from buffer solution, Scott and Fisher (*Biochem. J.* 1935, **29**, 1048) have shown that different samples of insulin hydrochloride having an ash content of 0·02 per cent., crystallised from an ammonium acetate buffer solution by means of zinc, cobalt or cadmium, showed constant values for the respective metals. The average ash content of each insulin salt was proportional to the atomic weight of the metal, and these facts indicate that crystalline insulin contains the metals as chemically combined constituents and not as impurities.

Science Notes.

Two Charophytes from Kolhapur (S. M. C.).—Mr. S. A. Parandekar, Rajaram College, Kolhapur, writes :—Among the flora of Kolhapur two species of Chara have been recently observed and identified as *Chara brachypus.* A. Br. and *Chara corallina* with the help of the key published by Allen (Charophyte Notes from Gonda, U.P., *J. Bombay Nat. Hist. Soc.*, 30, 589). The Charophytes from Kolhapur have not been so far recorded and studied, although about twenty species have been reported from Deccan. The report of the occurrence of the two charophytes might therefore prove of interest.

Chara brachypus A. Br. has been already reported from Bombay (Salsette island) by Dixit (*J. Ind. Bot. Soc.*. 10, 205) and by Allen from Gonda, U.P.

Chara corallina (which is not so abundant here as the other species) has been also recorded from Gonda by Allen, but not by Dixit from Bombay.

I am thankful to Mr. G. O. Allen, and Prof. S. C. Dixit, who have worked on Indian Charophyta, for informing me that Charophytes from Kolhapur have not been so far reported.

* * *

Awards of Silver Jubilee Medals.—We have great pleasure in felicitating scientists of India who have been decorated with Silver Jubilee Medals on the occasion of the recent Jubilee Celebration of H. M. the King-Emperor. The list given below is, however, incomplete.

Dr. P. K. Acharya, M.A., Ph.D., D.Litt.; S. P. Agharkar, Esq., M.A., Ph.D., F.L.S.; Rai Sahib Arthaballah Mahant; S. N. Bal, Esq., M.Sc., Ph.D.; Dr. Baini Prashad, D.Sc., F.R.S.E., F.L.S., etc.; D. V. Bal, Esq., L.Ag. (Hons.), A.I.C., F.C.S.; A. C. Banerji, Esq., M.A. (Cantab.), M.Sc.; S. B. Belekar, Esq., M.Sc.; D. Bhattacharji, Esq.; C. C. Calder, Esq., B.Sc., B.Sc. (Agric.), F.L.S.; H. Crookshank, Esq., B.A., B.A.I. (Dub.); J. F. Dastur, Esq., M.Sc., I.A.S.; M. L. De, Esq., M.A., I.E.S.; Deoras, Esq., M.Sc.; Dr. H. B. Dunnicliff, M.A., D.Sc., F.I.C.; Sir L. L. Fermor, O.B.E., A.R.S.M., D.Sc., F.R.S., etc.; Dr. C. S. Fox, D.Sc. (Birm.), M.I.Min.E., F.G.S., etc.; Babu S. K. Ganguli; Rao Sahib S. N. Godbole, M.Sc.; Dr. F. H. Gravely, D.Sc.; Dr. A. M. Heron, D.Sc. (Edin.), F.G.S., F.R.G.S., etc.; Dr. S. L. Hora, D.Sc., F.R.S.E., etc.; Jamaluddin, Esq.; Gurudatta Karwal, Esq.; R. P. Khosla, Esq.; Dr. K. Krishnamurthi, D.Sc.; D. N. Mehta, Esq., B.A. (Oxon.); Dr. E. P. Metcalfe, D.Sc., F.Inst.P.; M. A. Moghe, Esq., M.Sc.; Dr. A. L. Narayan, D.Sc., F.Inst.P.; Dr. B. K. Narayana Rao, B.A., M.B.C.M., M.R.C.S., D.P.H., D.O.; M. Owen, Esq., M.Sc., F.I.P., I.E.S.; G. R. Paranjpe, Esq.; M. W. Sayer, Esq., B.A., Dip. Agri. (Cantab.); D. R. Sethi, Esq., M.A., B.Sc.; Dr. F. J. F. Shaw, D.Sc. (Lond.), A.R.C.S., F.L.S.; Dr. B. K. Singh, M.A. (Cantab.), D.Sc., F.I.C.; Rao Bahadur B. Viswanath, F.I.C.; D. N. Wadia, Esq., M.A., B.Sc., F.G.S., etc.; Dr. T. S. Wheeler, Ph.D., F.I.C., F.Inst.P., M.I.Chem.E.

* * *

Origin, Scope and the Present Position of Potato Research at the Agricultural Research Station, Nanjanad.—The potato was introduced into the Nilgiris in the beginning of the nineteenth century. As the climate was quite suitable for its cultivation, it gradually extended and the local ryots (Badagas) finding the crop most remunerative took to its cultivation readily.

The crop now occupies nearly 11,000 acres. The potato is a very delicate crop and the ryots out of ignorance handled the crop carelessly and consequently deterioration set in rapidly.

As the crop is of very appreciable economic importance in the Nilgiris where it forms the main crop raised by the indigenous hill population and as its cultivation was threatened to extinction, the Government of Madras opened a Station in 1917 for the improvement of potatoes and supply of good seeds to the potato growers on the Nilgiris.

The Station is situated in the Nanjanad village and is 10½ miles from Ootacamund on the Governer Shola Road. The soil in the Station is a poor clayey loam and is typical of that to be found on the Nilgiris. It is all dry land. The Station is exposed to the South-West monsoon, the violent winds of which usually damage the potato haulms. The area of the Station is 161 acres and that under cultivation is nearly 45 acres.

The chief crop is potato, but korali and samai are grown in rotation and lupin, a leguminous crop, is grown as a green manure crop. Two crops of potatoes are grown annually the first being planted in March-April and harvested in August-September and the second sown in August-September and harvested in December-January. The bulk of the area is planted to first or main crop in the month of March-April.

Up to 1933, the work on potatoes was carried on in a restricted scale and was confined to the testing of improved varieties of potatoes, method of cultivation and manuring for the purpose.

The Government of Madras approached the Imperial Council of Agricultural Research for a grant for expansion of research work on potatoes chiefly with the object of breeding new varieties. The Imperial Council of Agricultural Research accepted the scheme and sanctioned a grant of Rs. 19,995 spread over a period of 5 years for research work on potatoes.

The work commenced from June 1933. A detailed study of the Botanical characters of all the varieties grown at this Station was made and a list of varieties that produce and retain flowers and those that bear visible pollen have been worked out.

Inter-varietal crosses have been carried out successfully and as many as 7 crosses have been obtained. The seedlings have been raised and are awaiting further study and selection of suitable types for cultivation. It is hoped that some of them may prove better than the existing varieties and a few may be fit for cultivation in the plains as well.

* * *

Combing of Good Quality Indian Cottons.—The Publicity Officer, Indian Central Cotton Committee, writes :—There is enough evidence to show that the present-day tendency in the cotton textile industry lies in the increased production of yarns of finer counts. This can be achieved either by using superior quality cottons or by subjecting cotton of a given quality to some such mechanical treatment as will appreciably raise its spinning performance.

Among the latter the most effective method now available is that known as combing. This method consists essentially in the extraction by the combing machine, of a known percentage of the relatively short fibres which are to be found to a greater or less extent in all cottons. The combing process besides serves to parallelise the fibres which results in a greater regularity and higher strength of the yarns. It also serves to reduce such undesirable features as neps from a cotton.

Hitherto the combing process has been almost exclusively restricted to the long staple non-Indian cottons. This restriction is presumably based on the assumption that combing, with its consequent rejection of a large percentage (generally from 15 to 25 per cent.) of the fibres, is economically suitable for such cottons only. In order to examine the limiting performance, as a result of combing, of Indian cottons and to test, among other things, the validity of this assumption, a series of experiments were carried out at the Indian Central Cotton Committee's Technological Laboratory, Bombay. Four Indian cottons of good quality were selected for these experiments. Each cotton was combed to the extent of 20 per cent. and 30 per cent. and spun into appropriate counts of yarn on a ring frame using the ordinary and a high draft system of spinning. The comber wastes extracted from these cottons were respectively mixed with four Indian cottons of suitably low quality, and the mixtures were spun into carded yarns of appropriate counts.

These tests form the subject of a Technological Bulletin (Series A, No. 27) of the Indian Central Cotton Committee. The bulletin comprises five sections and a comprehensive appendix and contains such items of practical interest as a description of the cottons and the machinery used in these tests and full details of treatment accorded to each sample. The results obtained are suitably tabulated and include particulars of fibre-properties, yarn test results, waste percentages, yarn breakages during spinning, and the strength, evenness and neppiness of the yarns spun from the various samples.

The joint authors, Mr. R. P. Richardson, F.T.I., and Dr. Nazir Ahmad, M.Sc., Ph.D., F.Inst.P., discuss the implications of the various results at some length and they offer the chief conclusions drawn from them in the form of a summary.

The work embodied in this bulletin is a valuable contribution to the subject of cotton combing and in its 31 pages will be found much data, of a specific character, which will be of great value to the practical spinner. The bulletin is available to the public at a nominal cost of Re. 1.

* * *

The Mysore Veterinary Medical Association, Bangalore.—The seventh annual conference of the Association was held on 22nd, 23rd and 24th June 1935. Sir K. P. Puttanna Chetty in opening the Conference eulogised the part played by the Veterinarian in the rural economy of the country and stressed on the point that control over the supply of wholesome milk and meat should be handed over to the Veterinary authorities. He hoped that every taluk in the State would soon be provided with a Veterinary dispensary. In referring to Veterinary Research he pointed out the importance of co-operation between the Medical Department and the Veterinary Department as both the Sciences were inter-dependent in matters of experiments on animals and their applicability to human beings. He also referred to the progress shown in the production and preparation of sera and vaccines at the Mysore Serum Institute, which are largely and effectively used both in and outside the State.

Mr. K. Krishnaiengar, Superintendent, Mysore Civil Veterinary Department, welcoming the delegates to the Conference pointed out that the members of the Veterinary profession in Mysore had succeeded in reducing the incidence of cattle disease to the lowest possible minimum by promptly adopting measures of control. He impressed on the members the need for further educating the private owners as well as the public bodies in the hygienic maintenance of live-stock. He further observed that no one was better qualified than the Veterinarian to be in charge of Inspection of milk and meat which are two of the most important foods of human beings. He deplored the apathy of the local bodies on this question as they do not seem to have yet realised the importance of such work.

Major R. W. Simpson in his inaugural address hoped that before long the Veterinary Department would be made an independent unit. Apart from his capacity to treat the sick animals and prevent the spread of contagious diseases the Veterinarian is well qualified to inspect animal food products, to certify for their wholesomeness and purity and thus prevent diseased meat and milk being sold. The Veterinary Surgeon in western countries plays an important rôle in matters relating to public health. He also referred to the live-stock trade which is one of the chief trades in Mysore amounting to a crore of rupees every year and made mention of the good work that is being turned out in the Cattle Breeding Station at Ajjampur, in the matter of improvement of live-stock. He next referred to Poultry Farming and congratulated the Government of Mysore on sanctioning funds for the purpose at Dodballapur and suggested that the breeding of poultry should be taken up in right earnest as it is indeed a profitable and useful concern.

Two resolutions were passed, one for the supply by the Government, of good breeding bulls and buffaloes to village panchayats to improve the breed of the cattle in those parts and the other for awarding a gold medal every year to the member who is adjudged to have done original scientific work.

On the second day twelve papers were read — Important among which were (1) "Local Anæsthesia with Planocaine", (2) "Variola in domestic animals, with special reference to Sheep-pox" and (3) "The Veterinarian's rôle in public health".

The members of the Association visited the Mysore Serum Institute on the 3rd day of the sessions where lectures and demonstrations were held on "The recent advances in the preparation of biological products" and "Epidural Anæsthesia" in animals. In the afternoon the representatives of the General Electric Company demonstrated the uses of the portable "X-Ray" set in animal practice.

The session came to a close after the departmental conference at which important matters

pertaining to the working of the Civil Veterinary Department in Mysore, were discussed.

* * *

Lady Tata Memorial Trust.—The Trustees of the Lady Tata Memorial Trust have announced the following Indian Scholarships for the year 1935-36, each of the value of Rs. 150 per month, for scientific investigations having a bearing on the alleviation of human suffering, on the occasion of the fourth anniversary of the death of Lady Tata.

(1) Mr. N. C. Datta, M.Sc., to study the rôle of nutrition and the effect on the body, of mineral contamination of foodstuffs during cooking and storage. (2) Mr. K. N. Gaind, M.Sc., to synthesise new compounds possessing local anæsthetic properties. (3) Mr. M. C. Nath, M.Sc., to carry out chemical and biological analyses of proteins of Indian foodstuffs. (4) Mr. Y. V. Sreenivasa Rau, M.Sc., A.I.I.Sc., to study the proteins of Indian foodstuffs, chemical and biological analyses (at Halle, Germany). (5) Mr. R. Chakrabothy, M.Sc., to investigate nutritional problems of Indian foodstuffs with special reference to Vitamin C. (6) Mr. N. B. Das, B.Sc., for work on the Oxytocic harmone and on oxidation-reduction systems in the body (at Stockholm). (7) Mr. T. N. Ghosh, M.Sc., A.I.I.Sc., for research on the preparation of new anti-malarials. (8) Mr. H. S. Mahal, M.Sc., to work on the anthelmintics, synthesis of substances and examination of Indian plants having anthelmintic properties. (9) Dr. B. K. Nandi, M.Sc., Ph.D., A.I.C., to work on the synthesis of anti-malarials on the line of plasmochin and atebrin types (at Oxford). (10) Mr. H. B. Sreerangachar, M.Sc., A.I.I.Sc., to investigate the growth-promoting and anti-anæmic properties of liver.

The trustees have also made eight international awards for research in diseases of the blood with special reference to leucæmias.

* * *

Pramatha Nath Bose Memorial Medal.—The Council of the Asiatic Society of Bengal has adopted the following regulations regarding the award of the medal:—(1) The Medal shall be awarded every three years at the Ordinary Annual Meeting of the Asiatic Society of Bengal in February. (2) The Medal shall be bestowed on a person, who, in the opinion of the Council, has made conspicuously important contributions to practical or theoretical Geology with special reference to Asia. (3) The General Secretary shall, at a meeting of the Council preceding the Ordinary Meeting in November, place before the meeting the names of at least three Geological experts and three members of the Society for consideration. The Council shall then proceed to appoint an Advisory Board of not less than three members selected from the list placed before them provided that the Council, for special reasons, shall be entitled to select persons outside the list. The Advisory Board shall always include two Geological experts and the General Secretary shall be an *ex-officio* member of the Board. (4) The Advisory Board shall be termed "The Pramatha Nath Bose Memorial Medal Advisory Board." The Board shall appoint a Chairman from amongst its members who shall have a casting vote (in addition to his own vote) in the event of the number of votes being equally divided. (5) The General Secretary shall call a meeting of the Advisory Board on the first convenient date subsequent to the first Monday of December, at the same time requesting members to bring with them to the meeting a detailed statement of the work or attainments of such candidates as they may wish to propose. The General Secretary shall also place before the Board for consideration detailed statements of the work or attainments of any other candidate submitted by any Fellow of the Society. The Board shall make such arrangements as may be necessary for the selection of a name to be submitted to the Council at their December meeting. (6) Notwithstanding anything determined in these Regulations, it shall be within the competence of the Board to abstain from the selection of any name to be submitted for the year and to report accordingly to the Council, in which case, provided the Council concurs, the award for the year shall lapse and shall be postponed to the next following year to be determined in the manner prescribed in the above rules, and, if necessary, deferred again year by year, until an award be made, the period mentioned in Rule 1 in such case to be reckoned from the date of the award.

* * *

The University of Madras has conferred the degree of Doctor of Science (D.Sc.) on (1) Mr. A. V. Varadaraja Iyengar, M.Sc., (2) Mr. P. P. Pillai, M.Sc., (3) Mr. C. Sambasiva Rao, M.Sc., and (4) Mr. C. P. Gnanamuthu, M.A. Mr. V. Krishnan, M.A., has received the degree of Doctor of Philosophy (Ph.D.).

* * *

Two Inscriptions from Barakar.—At the ordinary meeting of the Asiatic Society of Bengal, held on the 1st July, Dr. S. N. Chakravarthy read a paper on the two inscriptions which are found on the "right door-jamb of the Ganesha temple in the Begunia group of four temples at Barakar in the Burdwan District". He discussed the previous literature referring to the date of the inscriptions and believes that on palæographical grounds, Śaka 1468 or 1498 should be preferred. The Palæographical evidence was discussed at length and the transcription and translation of the inscription were also given.

* * *

It has been proposed to present Rajasevasaktha Rao Bahadur S. Krishnaswamy Iyengar, M.A., Ph.D., F.A.S.B., formerly Professor of Indian History and Archæology, University of Madras, with a commemoration volume of papers contributed by scholars both in India and abroad, engaged in the field of Indian Historical and Archæological learning and research, on the occasion of his sixty-fifth birthday (15th April 1936). An appeal signed by S. Radhakrishnan, Dr. Surendranath Sen, Dr. P. K. Acharya, Dr. Radha Kumud Mukherjee and a number of others has been issued, calling for donations towards the cost of printing the volume. All communications may be addressed to Mr. C. S. Srinivasachari, M.A., Professor of History, Annamalai University, Annamalainagar, or to Professor V. Rangacharya, M.A., L.T., "Sri Rangadaman," Lloyds Lane, Royapettah, Madras.

* * *

Rao Bahadur K. V. Rangaswamy Iyengar has been appointed Principal of the College of the Benares Hindu University.

Rt. Hon'ble V. S. Sreenivasa Sastri has been appointed Vice-Chancellor of the Annamalai University.

* * *

Rao Bahadur T. S. Venkataraman will represent India at the World Sugar Conference to be held at Brisbane, Queensland, in the last week of August.

It is understood that Dr. (Miss) E. K. Janaki Ammal will attend the Botanical Conference to be held at about the same time in Cambridge.

Dr. Issac, Second Imperial Entomologist, Pusa, will attend the Imperial Entomological Conference in London, after which he will visit the United States, Porto Rico and Hawaii Islands with a view to study the methods of Pest Control in regard to Sugarcane. The problem has acquired importance and urgency in view of the fact that considerable damage is being caused to sugarcane in United Provinces, due to insect pests.

* * *

Sir S. Radhakrishnan left India for Geneva to attend the forthcoming meeting of the International Committee of Intellectual Co-operation on 15th July. The meeting is expected to last for a week. Sir S. Radhakrishnan will visit Oxford, and is expected to return to India in August.

* * *

It is understood that Dr. C. P. Turner, Ph.D., Chairman of the Institute of Technology, Cambridge, Mass. (U.S.A.) has been appointed by the Calcutta University to deliver a course of six lectures on the following subjects relating to "Organisation of Health Education":—underlying principles in health education; construction of curriculum in health education; and school practices of health education.

* * *

Principal P. Seshadri, Rao Bahadur Thakur Chain Singh, Educational Minister, Jodhpur State, Principal A. A. C. Harvey and Principal F. G. Pearce, will constitute the delegation to the World Conference on Education. The Conference will be held at Oxford from August 10th to 17th and Principal P. Seshadri will lead the delegation.

* * *

Professor Brauner, prominent Czecoslovakian chemist, died in February at the age of 80. He was well known for his researches on the periodic system of elements. He was a pupil of Bunsen and Rowe, and by collaborating with Ramsay, Richards, Baxter, Dixon and Mendeleeff, he became a prominent figure in inorganic and analytical chemistry. It was due to him that oxygen was adopted as the basic element in calculating atomic weights. His researches were mainly confined to the rare elements and as a result of his work, beryllium was placed in the second group of the periodic table.

* * *

According to an *Associated Press* message the Government of Travancore are contemplating the starting of a factory for refining china clay and manufacturing porcelain at Kundara, near Quilon. The deposits of china clay at Kumbalom have been found to be of the standard quality. The deposits cover an area of over 30 square miles. It is reported that cheap skilled labour is also available.

* * *

From a report appearing in the *Hindu*, it is understood that proposals are submitted to the Government of Travancore for establishing a separate Fisheries Department instead of its being attached to the Agricultural Department as at present. Canning and cold storage are to be introduced; it is suggested that deep sea fishing should be started and the fish canning should be improved on scientific lines.

The Department now maintains four fishery schools where fisher boys and girls are given elementary schooling and the special fishery school at Karungapalli is making steady progress. Improvement and expansion of the schools, and the establishment of a library, museum and laboratory are also under contemplation.

The State has a fishing population of one and a half lakhs. 95 per cent. of the population eat fish and the foreign trade in fish amounts to 40 lakhs, and a maritime state like Travancore affords an almost untapped source of wealth in fisheries.

* * *

Manurial Research in Travancore.—Among the important manurial experiments which are in progress in the State, mention may be made of (1) the effect of phosphatic, nitrogenous and general manures on paddy cultivation in South Travancore. Superphosphates have given the highest yield; (2) comparison of the values of artificial manures and green manures on paddy; and (3) improvement of alkali soils by the application of special green manures.

* * *

The research work done in India on sugarcane both in its agricultural and manufacturing side since 1932, was reviewed at a recent meeting of the Sugar Committee of the Imperial Council of Agricultural Research. The review shows that the progress made has not kept pace with anticipations and that if the present rate was not accelerated India would not be able to stand on her own legs within the period of protection. The paucity of funds for sugar research and the fact that the Central Research Institute had not been started early enough are the two causes responsible for the slow progress.

* * *

The Terminology of Illumination and Vision. H. M. Stationery Office. Price 6*d.* net.—This paper, of which an up-to-date revised edition is now issued, contains definitions and clear explanations of all the common physical, physiological and ophthalmic terms used in the study of the problems of illumination, the understanding of which is essential to all who wish to follow the rapid progress now being made in their solution.

* * *

Research in Tuberculosis.—It is understood that the Italian Fascist National Federation against Tuberculosis has placed six scholarships at the disposal of the International Union against Tuberculosis of Paris at "Carlo Forlaniani" Institute in Rome for the session from November 15, 1935 to July 15, 1936.

These scholarships are intended for foreign medical practitioners who are already familiar

with tuberculosis problems, and who wish to improve their knowledge in this branch of medicine.

* * *

Occupational Diseases.—Certain occupational diseases, *e.g.*, silicosis, arsenic poisoning, pathological manifestation due to radium and other radioactive substances, epitheliomatous cancer of the skin, will, it is understood, be added to the list of diseases now coming under the convention regarding workmen's compensation for occupational diseases. The most important of these is silicosis, which is associated in other countries with gold mining and with many common industrial processes of which sand-blasting, manufacture of china glass and pottery and stone cutting are examples. Silicosis cannot ordinarily be diagnosed definitely except by well-equipped radiological apparatus, and the Government of India according to an *Associated Press* message have started enquiries regarding the availability of facilities for such tests in the various industrial areas.

* * *

Sir Asutosh Mukherjee Memorial Institute.—The Minister of Education, Bengal, performed the opening ceremony of the Memorial Building on June 29th. The building will not only house the Institute but the Asutosh College founded by him at the beginning of the present century. "It would be a meeting place for people of all nationalities, united by a permanent bond of fellowship based on honourable understanding and determination to advance the best interests of the province and the country."

* * *

Royal Institute of Science, Bombay.—Prof. R. H. Dastur, Head of the Botany Department, has gone on deputation as Plant Physiologist under the Indian Central Cotton Committee, Lyallpur (Punjab).

Mr. G. V. Jadhav of the Chemistry Department has sailed for higher studies in the University of Manchester as one of the Sir Mangaldas Nathubhai Scholars of the Bombay University.

As a result of Scientific Exhibition organised by the Institute in December last in aid of Bombay Hospitals a net sum of Rs. 17,500 has been made over to the Hospitals Fund Committee.

The staff and students of the Institute have collected about Rs. 250 in aid of the Quetta Earthquake Relief Fund.

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The aluminium globe in which Professor Piccard and M. Max Cosyns made their second ascent into the stratosphere three years ago was presented to the South Kensington Museum, London. The actual presentation was performed by M. Jean Willems, who was accompanied by the two scientists.

* * *

Sir E. Shackleton's famous ship, the "*Quest*" will leave shortly for the Arctic carrying an expedition which will explore the area of latitude 70° for geographical purposes. The expedition will be led by Mr. F. L. Wager, who will be accompanied by his wife. The second in command is Mr. Court Aulo, who, four years ago, spent the whole of one winter alone in a remote part of Greenland, snowed up in a small hut.

* * *

Microvivarium.—The microvivarium which, according to Dr. Frank Thore, is the "biological analogue of the Planetarium," is a highly useful instrument for clear and effective instruction in biology and therefore constitutes an indispensable complement to laboratories, museums or botanical and zoological gardens. In a paper appearing in the *Educational Screen*, April 1935, Dr. Georg Roemmert has given an account of this device. The microvivarium exhibit attracted a great deal of attention at the Century of Progress. "In the microvivarium the micro-projection method has been used on a large scale for the first time. This method shows essentially the same things as we otherwise perceive in a microscope. The image is produced from the object itself, by the objective of the microscope with all its colours and movements. The difference is simply that in micro-projection the picture, in huge magnification, appears on a screen, and consequently observation on a microscope is rendered superfluous. The great advantage of this method for popular presentations is that explanations can be given once only for all observers and there is no necessity for unpractised layman to manipulate the microscope. Moreover, objective demonstration in the enormously magnified field of vision, over one yard in diameter, leaves behind an unforgettable impression."

* * *

According to a Calcutta message three earthquake shocks, one of considerable intensity were felt at Siliguri, Bengal, on Thursday, the 4th July. No loss of life or damage to property has been reported. Shocks were also felt at Kalipong and Jalpaiguri in the Dinajpur District.

* * *

The second meeting of the Imperial Sericultural Committee will be held at New Delhi on Wednesday, October 30, 1935. The meeting will consider the progress of the schemes, which have been initiated recently with the aid of the grant given by the Government of India for the purpose and will advise on the allotment of funds available for 1936-37. The schemes started in Bengal, Assam, Madras, Bihar and Orissa and Burma are designed mainly to increase the production of disease-free seed. There are also schemes for investigation of questions connected with silkworm disease.

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Announcement :—

Fifth Congress of the International Society of Sugarcane Technologists (Brisbane, Australia, August, 1935).—The International Society of Sugarcane Technologists is to meet at Brisbane in Australia on the 27th August, 1935. This Society, which generally meets once in three years and alternately in the Eastern and Western hemispheres, has already held four sessions, *viz.*, in Hawaii, Cuba, Java and Puerto Rico. The one at Brisbane is to be the Fifth Congress of this body.

Visits to experiment stations and excursions to factories and sugar plantations have been important adjuncts to the meetings of the Congress. While the actual sessions at Brisbane are to last about a week from 27th August, excursions are to occupy a fortnight after the meeting. We learn that leaders of the Sugar Industry in Australia are to deliver addresses at Brisbane so as to give the delegates to the Congress a true perspective of the special conditions obtaining in the Australian Sugar Industry.

One special feature of the industry in Australia is the employment of White labour alone.

The Congress is to consist of eight different sections representing the various aspects of the Sugar Industry. In the manufacturing section a special feature will be "Sugar boiling with particular reference to the refining quality of raw sugar". Plot technique is to receive attention on the agricultural side; and we learn there is to be a symposium on the very important subject of selection of useful types in sugarcane breeding. Australia is said to be a land of diseases and the Pathological section—including virus diseases and quarantine—is expected to be particularly instructive. Testing of new varieties for disease resistance and control of diseases by cultural operations are two of the rather attractive items in the programme of the Congress.

The Australian Government and the Sugar Industry are doing their best to render a visit to the Congress both comfortable and instructive. In India there are as many as 28 members of this Society representing the various lines of Sugar Research in the country and the Industry in all its aspects. About half a dozen delegates from India are expected to attend the Brisbane Congress.

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We acknowledge with thanks the receipt of the following :—

"Journal of Agricultural Research," Vol. 50, Nos. 4 and 5.

"Journal of Agriculture and Live-stock in India," Vol. 5, No. 2.

"The Journal of the Royal Society of Arts," Vol. LXXIII, Nos. 4305–08.

"Biochemical Journal," Vol. 29, No. 5, May 1935.

"American Journal of Botany," Vol. 22, No. 5, May 1935.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 6, June 1935.

"Canadian Journal of Research", Vol. 12, No. 5, May 1935.

"Chemical Age," Vol. 32, Nos. 830–833.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 6,

"Ceylon Journal of Science,"—

Section A,	Vol.	XII,	Part 1.
,, B,	Vol.	XIX,	Part 1.
,, C,	Vol.	V,	..
,, D,	Vol.	III,	Part 3.
,, E,	Vol.	I,	Part 3.
,, G,	Vol.	II,	Part 3.

"The Journal of the Indian Chemical Society," Vol. 12, No. 4, April 1935.

"Experimental Station Record," Vol. 72, No. 5, May 1935.

"Journal of Entomology and Zoology," Vol. 27, No. 1.

"Indian Forester," Vol. LXI, Nos. 6 and 7.

"Forschungen und Fortschritte," Vol. 11, Nos. 15–18.

"Indian Forest Records," Vol. 20. Pt. 15.

"Advance Proceedings and Notices of the Asiatic Society of Bengal," Vol. II, No. 3, June 1935.

"National Geographic Society, Stratosphere Series," No. 1.

"Indian Physico-Mathematical Journal," Vol. 6 No. 1, April 1935.

"Monthly Statistics of the Production of Certain Selected Industries of India" (Government of India Publication), No. 10 of 1934–35, January 1935.

"Department of Scientific and Industrial Research : Report of the Chemistry Research Board for the period ended 31st December 1934, with Historical Introduction and Report by the Director of Chemical Research."

"Mitteilungen über Neuerscheinungen und Fortsetzungen" 1935, No. 3.

"Proceedings of the Association of Economic Biologists, Coimbatore," Vol. 2, 1934.

"Acta Phytogeographica Suecica VII. Das ozeanische Element der Strauch-und-Laubflechten-Flora von Skandinavien."

"Mathematics Student," Vol. III, No. 1, March 1935.

"Medico-Surgical Suggestions," Vol. 4, No. 5.

"Scripta Mathematica," Vol. III, No. 2, April 1935.

"Nagpur Agricultural College Magazine," Vol. 9, Nos. 3 and 4.

"Nature," Vol. 135, Nos. 3421–3424.

"The Journal of the Bombay Natural History," Vol. 37, No. 4.

"The Journal of Nutrition," Vol. 9, No. 5.

"The Journal of Chemical Physics," Vol. 3, No. 6, June 1935.

"Journal de Chimie Physique," Vol. 32, No. 5.

"Indian Journal of Physics," Part IV (and "Proceedings of the Indian Association for the Cultivation of Science," Part IV).

"The Indian Trade Journal," Vol. CXVII, Nos. 1512–1515.

Academies and Societies.

Indian Academy of Sciences.

June 1935. SECTION A.—C. V. RAMAN: *On Iridescent Shells. Part III.—Body-Colours and Diffusion-Haloes.*—The paper describes a group of interesting optical phenomena which have their origin in the granular and colloidal structure of nacre and have no analogue in the optics of transparent stratified films. S. RAMA SWAMY: *X-ray Analysis of the Structure of Iridescent Shells.*—There is a significant and close correspondence between the results of the X-ray investigation and the diffraction haloes observed by Sir C. V. Raman. The nacreous layers of all the shells consist of aragonite crystals oriented with their C-axes normal to the surface. G. R. PARANJPE AND P. Y. DESHPANDE: *Dielectric Properties of Some Vegetable Oils.*—Castor, olive, sesame and cocoanut oils both in the pure state and in solutions in benzene have been studied. K. NEELAKANTAM, R. H. RAMACHANDRA RAO AND T. R. SESHADRI: *Pigments of Cotton Flowers. Part I.—Cambodia* (Gossypium hirsutum).—The composition of the pigment from the flower petals varies with the variety, locality and with the season. N. B. BHATT: *High Frequency Spectrum of Mercury Vapour.*—In the feeble blue discharge conditions are more favourable for bringing out the spark lines and some higher members of the arc lines both of which are absent in the high excitation spectrum. T. S. WHEELER: *The Electrostatic Potential of a Crystal of the Cuprite type.*—A simple method for the calculation of the potential of cubic crystal lattices has been applied to the calculation of the electrostatic potential of cuprite. R. S. KRISHNAN: *Molecular Clustering in Binary Liquid Mixtures.*—Molecular clusters exist not only at the critical solution temperature but also at temperatures considerably removed from it. S. SASTRY: *On Sums of Powers.* S. CHOWLA: *A Theorem on Sums of Powers with Applications to the Additive Theory of Numbers (III).* K. RANGASWAMI: *The Theory of Normals to a Quadric in Hyperspace.* D. D. KOSAMBI: *Homogeneous Metrics.* B. VENKATESACHAR AND L. SIBAIYA: *Platinum Isotopes and Their Nuclear Spin.*—These results are obtained from an examination of the hyperfine structure of some ten lines in the arc spectrum of platinum.

SECTION B.—N. N. DASTUR, (MISS) R. KARNAD, B. N. SASTRI AND A. VENKATASUBBAN: *Estimation of Urea.*—A simple titrimetric method for the estimation of urea, consisting in the preliminary hydrolysis by urease and subsequent titration of the ammonium carbonate produced by standard alcoholic HCl in presence of acetone, has been described. G. NARASIMHA MURTHY AND V. SUBRAHMANYAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition. Part VII. Economy of Carbon during Decomposition of Cane Molasses in the Swamp Soil.*—A part of the added organic matter passes into the soil sediment and the rest with the supernatant. During the puddling and flooding processes almost the entire quantity of the added organic matter is washed off by the water. S. C. VERMA: *Studies on the Indian Species of the Genus* Echinochasmus, *Part I. and on an Allied New Genus* Episthochasmus.—The presence of a chambered excretory bladder in some Echinostomatid genera is reported for the first time. A new genus *Episthochasmus* is created from a new species of parasitic Echinostomatid from the common dog of Calcutta. The generic diagnosis of the new genus and the new species *E. caninum* is given. G. N. RANGASWAMI AYYANGAR AND KUNHI KRISHNAN NAMBIAR: *Studies in* Dolichos lablab *(Roxb.) and (L.).—The Indian Field and Garden Bean. I.*—The inheritance of the characters of the bean has been studied and reported. B. A. SUNDARA IYENGAR AND V. SUBRAHMANYAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition. Part VIII. Influence of Fermentable Organic Matter on the Transformations of Iron in the Swamp Soil.*—Fairly large quantities of ferrous iron were brought into solution on adding commercial glucose to peaty and laterite soils. The ferrous iron is largely present in combination with the organic acids produced during fermentation. VISHWAMBHAR PURI AND BAHADUR SINGH: *Studies in the Family Amaranthaceæ. I. The Life-History of* Digera arvensis *Forsk.* B. N. SINGH AND K. KUMAR: *The Influence of Partial Pressure of Carbon Dioxide on Photosynthetic Efficiency.*—The nature of the relationship between the supply of carbon dioxide and the rate of assimilation by radish leaves, has been studied. G. S. SIDDAPPA AND V. SUBRAHMANYAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition. Part IX. Oxidation of Organic Matter in the Soil and Plant Assimilation.*—Treatment of soils with minute quantities of chemical oxidisers such as permanganate, hydrogen peroxide or ferric oxide helps to increase the availability of the organic matter of the soil.

Indian Chemical Society.

April 1934. PANCHANAN NEOGI AND (*Late*) GOPAL KRISHNA MUKHERJEE: *A New Method of Preparing Organo-Mercury Compounds of Phenol and Aromatic Amines, Part II.* K. MADHUSUDANAN PANDALAI: *The "Electron Transfer" Theory Applied to the Reactions in the (Photographic) Developing Bath.* MOHAN SINGH: *Studies on Optical Activity and Chemical Constitution. Part I. Optically active Bases and Acids.* P. PARAMESWARAN PILLAY: *On Anacardic Acid, Part I. Anacardic Acid and Tetrahydro-anacardic Acid.* P. PARAMESWARAN PILLAY: *On Anacardic Acid, Part II.—The Construction of Tetrahydro-anacardic Acid.* BASHIR AHMAD, RANCHODJI DAJIBHAI DESAI AND ROBERT FERGUS HUNTER: *The Formation and Stability of Polybromide Derivatives of Heterocyclic Compounds. Part V.—The Bromination of some 1-Aryl-imino-3-aryl-4-keto-5-methyl-tetra-hydrothiazoles and their 5 : 5-dimethyl Homologues and some Remarks on the Theory of Singlet Linkages.* PHULDEO SAHAY VARMA AND K. S. VENKATARAMAN: *Halogenation. Part X.—Preparation of Mixed Halogen Derivatives of Xylenes.* SUSIL KUMAR RAY: *Parachor and Chemical Constitution. Part II.—The Structure of the Triphenylmethane Dyes.* JAGARAJ BEHARI LAL AND SIKHIBUSHAN DUTT: *A Yellow Colouring Matter from the wiid of* Adina cordifolia. *Hook.* JAGARAJ BEHARI LAL AND SIKHIBUSHAN DUTT: *Chemical Examination of* Butea frondosa *Flowers.*—Isolation of a Crystalline Glucoside of Butin. B. K. MENON AND D. H. PEACOCK: *The Rates of Racemisation of Acids of the type R_1 (R_2)-CH. COOH.* K. VENKATA GIRI AND J. G. SHRIKHANDE: *Studies on Salt Activation. Part I.—Influence of Neutral Salts on the Enzyme Hydrolysis of Starch.*

Reviews.

X-RAYS IN THEORY AND EXPERIMENT. By Arthur H. Compton, Ph.D., Sc.D., LL.D., Nobel Laureate and Dr. Samuel K. Allison. (Macmillan & Co., 1935.) Pp. 828. Price 31*s*. 6*d*.

This is the second and revised edition of Prof. Compton's well-known book *X-Rays and Electrons* first published in 1926. The first edition and a revised reprint of the same were soon sold out. The present revised second edition was announced some two or three years ago but as the senior author remarks in the preface "attempts at revision could not keep pace with the rapid growth of the subject". Prof. Dr. Allison who joined in collaboration is a well-known authority on X-rays, and has taken the primary responsibility for the greater part of the present volume, such as X-rays and crystals, dispersion and absorption and X-ray spectra.

The subject-matter is divided into nine chapters, appendix and index, comprising 828 pages. The first chapter gives a wonderfully clear and concise presentation of X-rays and their properties written by Prof. Compton himself, bringing out the advances in the whole field of X-rays which have been treated in detail in the rest of the chapters. The second chapter deals with the production of X-rays from the point of view of different theories and their experimental verification. The third chapter also written by Prof. Compton is divided into four parts and deals with scattering by independent electrons, interference with scattered X-rays, the corpuscular aspects of X-rays and the wave-mechanical theory of X-ray scattering. Dispersion theory applied to X-rays is dealt in chapter IV and the study of crystal structure in chapter V. Diffraction of X-rays from crystals is dealt in two parts from point of view of perfect crystals and second of imperfect crystals. The phenomena of ionisation, fluorescence, magnetic spectra, absorption and ejection of photo-electrons are treated in chapter VII. The next chapter is on the interpretation of X-ray spectra and includes systematisation, relative intensities as well as good discussions on non-diagram lines, absorption edges and chemical effects. The last chapter is devoted to a discussion of accurate methods of X-ray wave-length measurements and their results. It includes discussions on double spectrometer measurements and focussing X-ray spectrographs. There are 11 appendices dealing with subjects like velocity of wave groups, atomic structure factors, electronic structure of elements and discussions of Ewald's reciprocal vectors which have been found very useful in the study of crystals having non-orthogonal axes.

This much-looked-for book is unique in its importance and indispensable to advanced students in general and research workers in particular. It is with great difficulty that the authors have managed to give a presentation which, while it is not loaded with the great amount of matter that had accumulated, is at the same time thoroughly adequate and convincing. Full credit is given to all workers in the field. In the introductory first chapter, for example, results of Bohr's theory on energy levels etc., are taken and the screening constant is put in as a correction due to the repulsion of other electrons wisely avoiding any derivation of these. The authors remark "other methods of calculating these have been proposed by Sommerfeld, Heisenberg, Schrödinger and others. From the standpoint of the assumptions involved, these recent theories are preferable; but the calculations are more complex and the results are very nearly the same as those reached by Bohr. It is probably safe to say that the Bohr theory offers as satisfactory a *picture* of what happens in the atom when radiation is emitted as can at present be supplied". Further in preference to their own earlier photographs, the authors reproduce only the excellent photographs of Du Mond and Kirkpatrick on the scattering from carbon showing the Compton shift and obtained by the use of their multiple crystal spectrograph. In a note the authors remark "among those who have published experiments showing the type of spectrum described above are:" and a list of about thirty original papers are given.

We are happy to note that the work of Indian workers in the field has received adequate recognition.

One does not like to find fault with a book so masterly written. It is, however, difficult to follow figures 1-25 given on p. 29 to illustrate the Bragg law. The interfering beams are shown parallel to each other, one wonders how they could meet and interfere. The get-up of the book is excellent and typing

errors found here and there in first edition are absent in this edition.

B. DASANNACHARYA.

* * *

THE STRUCTURE AND PROPERTIES OF MATTER. By Herman T. Briscœ. (McGraw-Hill Book Company, Inc., New York and London. First Edition, 1935.) Pp. vii+420. Price 21*s.* net.

The book under review is of great interest to those who wish to learn the fundamentals of the Physics and Chemistry of atoms. The author's aim has been to describe the physical concepts concerning the structure of different forms of matter in relation to their chemical properties. In the first three chapters of the book there is a nice historical review of the growth of the atomic concept from the time of the ancient Greek Philosophers to the time of the discovery of Radioactivity. Then follow chapters on Radioactivity, the Electron, Protons, the atomic nucleus, the determination of nuclear charge, structure of crystals, Octet theory, Bohr's theory, distribution of Electrons about the nucleus, valency and lastly, the new Quantum Mechanics. The author's object throughout has been to treat the subject from the view-point of the chemist rather than that of the physicist. It is not, therefore, surprising that the abstruse mathematical steps that are introduced in treatises on the subject have been rigorously avoided, and the final results have been given with their physical and chemical significance. The author has chosen a happy *via media* between a "popular" book and an exhaustive treatise. The chapter on the new Quantum Mechanics gives a very clear account of the recent advances without the introduction of mathematical formulæ, and serves as an excellent introduction to the subject.

The references given in the book are to the standard text-books and treatises on the various aspects of the structure of matter. It should have been much more useful to those who wish to pursue the subject further, if references to the more important original papers had also been incorporated. The Octet theory though mainly of historical interest now, has been given a little too much space. We should have very much welcomed a more detailed treatment of recent topics like Artificial Radioactivity and the Hydrogen Isotope. Almost the whole book is confined to the structure of the atom rather than the molecule. A chapter on the structure of molecules, a subject of supreme interest to Physicists and Chemists alike could have been added with advantage. One feels disappointed to find no mention of Raman Effect and its applications to chemistry.

This book fulfils to a remarkable extent the long-felt need on the part of students of Chemistry of a suitable book which deals with the varied aspects of the structure of matter, not usually available in a single text-book. Though the book is highly useful for the students of the Honours classes, its high price may preclude its use as a text-book.

M. P. V.

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THE DISCOVERY OF SPECIFIC AND LATENT HEATS. By Douglas McKie and Niels H. de V. Heathcote. (Edward Arnold & Co., London, 1935.) Pp. 155 and six plates. Price 6*s.* net.

Nowadays the history of Science is coming to be regarded as important as the history of Kings and Empires and we find that an increasing measure of accurate and painstaking scholarship is being devoted to the subject. The volume before us is a welcome addition to the growing literature on the history of Science and describes an important chapter in the development of Physics. The researches of Black, Irvine and Watt on the one hand and of Krafft, Richmann and Wilcke on the other, are described and their several claims are judiciously appraised. The material has been taken from original sources and the story is told in the investigators' own words as far as possible. Much sympathy and understanding are necessary to penetrate the obscure thought and quaint reasoning employed in the infant stage of the science: the authors have succeeded very well in making these intelligible to the reader. The plates giving portraits of the important personages in this drama enhance the value of the book. Some long current notions are shown to be ill-founded such as the idea that Black designed and used an ice-calorimeter, which is embellished in most text-books by a drawing of the apparatus. We recommend the book warmly to all students of the history of Science.

T. S. S.

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"HAND UND JAHRBUCH DER CHEMISCHEN PHYSIK" unter mitwirkung Zahlreicher Fachgenossen Herausgegeben von A. Eucken Göttingen und K. l. Wolf Keil. Band 9.

Abschnitt I. "Atomspektren" von H. Kuhn, Oxford. Mit 78 Figuren im text. (Akademische Verlags-gesellschaft M. B. H., Leipzig, 1934.) Pp. 265. Price R.M. 26.

Atomic Spectra by H. Kuhn of Oxford forms the first part of Volume 9 of the series appearing under the title *Hand and Year Book of Chemical Physics* published with the co-operation of numerous scientific workers and edited by Eucken of Göttingen and Prof. Wolf of Keil. Dr. Kuhn has developed his subject from four main aspects, namely, the empirical foundations of atomic spectra, the theoretical foundations of atomic spectra, the structure and character of various spectra and lastly, the structure of the individual spectral lines themselves. In Section A the author begins with a brief description of the various spectroscopic instruments employed in the study of visible, ultra-violet and X-ray regions and then passes on to the empirical classification of simple spectra. Section B dealing with the theoretical foundations of the problem has been dealt appropriately enough first with Bohr's theory of atomic spectra and then the corresponding wave mechanical theory. Section C dealing with the structure and character of the various spectra has naturally been considered at some length. Even here the treatment is no doubt complete dealing as it does with subjects like multiplet structure, Zeeman effect, Stark effect, periodic table and X-rays and lastly, the many electronic or complex spectra, but one feels that the whole treatment is too brief. Section D deals with the structure of the individual spectral lines and the natural width and other influences on the spectral lines. Here again we are of the opinion that the author has not given the problem of hyperfine structure of spectral lines the importance that it deserves, it being one of the live problems of the day. Finally, we no doubt agree that this is a fitting companion volume to the series forming the *Hand and Year Book of Chemical Physics*. It would certainly have served a more useful purpose if it had only been enlarged and not condensed into such a small volume. The printing and general get-up of the book comes up to the usual high standard set by the German publications.

B. V. R.

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AN INTRODUCTION TO THE MODERN THEORY OF VALENCY. By J. C. Speakman. (Messrs. Edward Arnold & Co., London, 1935.) Pp. vii+157. Price 4*s*. 6*d*.

Since the discovery of the electron in 1897 by J. J. Thomson and the nuclear atom by Rutherford in 1911, the developments of the last decade have gradually tended to the general acceptance of the electronic theory of valency and no small part of its triumphs is due to the British School of Scientists. It has united under a single self-consistent viewpoint the three pre-existing partial theories of valency for ionising, non-ionising and molecular compounds.

This modest looking volume by one of the workers in the field gives a lucid exposition of the theory. The essential distinction between electrovalency and covalency, the structure of cyanides and isocyanides, the three electron bond of Pauling and a suggestive chapter on elementary wave mechanics, have been clearly and convincingly presented, the lines along which future advance is to be looked for, being also briefly indicated. The author has taken special pains to suggest a definite system regarding symbolization and terminology of the different types of valencies. A few omissions like that of metallic conduction do not detract from the merit of a book of this introductory character. The treatment is simple, elegant and sufficient and no better introduction can be recommended to one, at present, who wishes to acquaint himself with the modern theory of valency.

B. S. R.

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LA SYNTHESE ASYMETRIQUE. By J. P. Mathieu. (Actualités Scientifiqués et Industrielles, No. 209. Hermann et Cie, Paris, 1935.) Pp. 29. Price 8 Fr.

This is a lucid exposition of the present state of the subject of total or absolute asymmetric synthesis. While partial asymmetric synthesis, that is, synthesis under the directing influence of an already active substance has been achieved in a number of cases, the complete asymmetric synthesis without the influence of any living organism or its product has met with varying amounts of success and failure. The best results have been obtained by using circularly polarised light, and the present monograph recounts in a concise manner the methods and principles involved in the choice of this light energy, and ends with a critical examination of both the positive and the negative results obtained. The monograph will be

found to be highly interesting both to the general reader and the specialist.

M. A. G.

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ELEMENTARY SOLID GEOMETRY. By Naik and Bondale. (Arya Bhushan Press, Poona.) Pp. 214. Price Rs. 2–4–0 net.

The book is well adapted for the use of students of the Intermediate classes. Its main features are a copious collection of examples, a nice and interesting chapter on Preliminary Experimental work and a concise set of postulates. A successful attempt has been made to minimise the number of propositions by appending several results as simple deductions at the end of many of them. The book may appeal to a wider circle of readers if a few chapters on Geometrical Perspective Drawing as taught in the First Year Engineering classes are added.

M. VENKATARAMA IYER.

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DICTIONNAIRE DE LA CHIMIE ET DE SES APPLICATIONS. By Clement Duval, Raymonde Duval, and Roger Dolique. With a Preface by H. Luc. (Hermann & Cie, Paris.) Pp. xxxii + 747. Price 90 Francs.

This important publication is intended only for readers who have an adequate knowledge of the French language. It is not a French–English dictionary dealing with chemical topics.

The 747 pages of this work are packed with information of such an exceedingly useful character as to entitle it to be included in the usual list of books of ready reference. For instance, under cobalt is listed more than 250 of its compounds, each one of them with the appropriate formula. The organic compounds, including those recently investigated, are listed under the appropriate heads and their accepted nomenclature and formulæ are clearly indicated. Being of the nature of an encyclopædia, the material is arranged in alphabetical order which greatly facilitates the task of reference.

The work under review gives not only a list of compounds but indicates at the same time the meaning and significance of the various operations connected with them in the chemical laboratory and industry. It will undoubtedly serve a useful purpose especially in satisfying the immediate needs of workers who are far away from well-equipped libraries.

K. R. K.

VAN NOSTRANDS' CHEMICAL ANNUAL. A handbook of useful data for analytical, manufacturing and investigating chemists, chemical engineers and students. Edited by Prof. John C. Olsen. Seventh Issue, 1935. Pp. xviii + 1029. Price 25*s*.

The seventh issue of this well-known handbook, which has been recently published, will be welcomed by every serious student of Chemistry. Handbooks get rapidly out of date as accurate data accumulate, and therefore need periodic revision. The new edition of the *Chemical Annual* which is being repeatedly improved upon, incorporates a large number of new and useful tables dealing with physical and chemical data and tables giving boiling points, vapour pressures and latent heats of evaporation. The chemical engineers, in particular, will find this handbook invaluable and the well-known author of the "Unit processes and principles of chemical engineering" who has edited this handbook with the help of Dr. B. Whitney Fergusson, as Assistant Editor, and 13 contributors, has spared no pains in bringing out a thoroughly revised and up-to-date handbook.

The publication of handbooks and dictionaries involves a stupendous amount of meticulous care and labour. It is very difficult to review also these publications. Publications which have undergone several editions should be reliable due not only to the fact that they have undergone revision but also because, the chemists, who consult these handbooks, will draw the attention of Editors, in regard to errors in preceding issues and suggest addition of new tables and data. The Editor of *Chemical Annual* has earned the gratitude of a very large community of scientists, who will have numerous occasions to consult the book in the course of their professional work.

A very useful list of the more important books published since 1926 has been included and with the help of the index which serves as a guide to content matter, it is easy enough to locate the pages in which the required data are to be found. The get-up of the book is excellent.

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CHEMISTRY IN COMMERCE. (George Newnes, Ltd., London, 1935.) Vols. III and IV. Pp. 777–1544 + iv. Issued in 16 parts of 1/- each.

The four volumes of *Chemistry in Commerce* which were issued in 32 weekly instalments have recently been completed.

One cannot fail to be struck by the encyclopædic information which the volumes comprise and it can be safely said that we have here, a valuable work, copiously illustrated, at comparatively small cost, which the practising chemist will find numerous occasions to consult.

The subjects dealt with are of varied interest. History, Laboratory devices, analytical control in various industries, etc., are all dealt with by authorities who, by virtue of their intensive works experience, have described in precise terms, with numerous illustrations, the relevant details in simple and eminently understandable language. The chapters on bacteriological research (pp. 1161–1166), Pasteur and fermentation industries (pp. 777-778) make excellent reading. Under Chemistry in Stratosphere (p. 1027), a short account of how Professor Piccard carried a small air-conditioning laboratory into the stratosphere, is described. The chapter on Poison Hazards in Industry (pp. 1430-1435), is invaluable to every chemist. Under Accidental Discoveries in industry (pp. 1158-1160), several instances are described where discoveries were made not entirely by design. "In the field of observation chance only favours those who are prepared" (Pasteur, 1854). "Many men who are very clever—much cleverer than discoverers—never originate anything" (Darwin, 1871). These serve to show how luck enters the field of discoveries. The theme of each chapter has been logically developed. Thus in the chapter on High Speed Centrifuges (pp. 1001-1005), we have first a section on some typical applications, then follows an explanation of centrifugal force and finally a section on the care and maintenance of centrifuges. There are also several notes on the care and maintenance of chemical plant, such as autoclaves (p. 1367) and, on the use of synthetic resins for acid-proofing of chemical plant (p. 1157). Of particular interest are the chapters on measurements of high temperature (p. 1397) and on the use of Parr Bomb calorimeter (pp. 1190-1195). The chemistry and pharmacy of vegetable drugs are dealt with in 14 parts and are systematically treated. The pressure control bottle described on p. 1010, the mechanical shaker prepared from an old bicycle wheel (p. 1042) and the filtering apparatus to maintain constant head described on p. 819 and many other highly useful but simple laboratory devices are to be found throughout the text. The examples mentioned here serve to show the variety of features covered by the book.

One wonders why the manufacture of tea and coffee has escaped the attention of the Editors. On p. 1280, under hydrogenation, molebdinum is spelt as molebdinium. No reference is made to honey under foods. The electrodeposition of lac, a process which has been recently developed (*Chemistry and Industry*, 1934, **26**, 882) has not found a mention in the chapter on lac.

The volumes are, undoubtedly, of the highest interest and we expect that they will gain the popularity which they deserve. Every student of chemistry should learn the ramifications of the subject he is studying and books written in such an easy and understandable manner and still conveying such authoritative information on a large variety of topics, are indeed rare.

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THE CARBOHYDRATES. By E. F. Armstrong and K. F. Armstrong. (Longmans, Green & Co., London, 1934.) Pp. vii+252. Price 15*s*.

During the last quarter of a century Armstrongs' monograph "The carbohydrates and glucosides," has been an indispensable volume in the library of every one interested in the chemistry of sugars. The growth of knowledge in this important field of chemistry necessitated the separation of the glucosides, and a separate monograph entitled "Glycosides" by E. F. Armstrong and K. F. Armstrong, appeared in 1931. The publication under review completes the work of revision and the two companion volumes constitute a masterly exposition of a highly intricate subject.

The volume was eagerly awaited for some years past, notably as a result of the great advances on the structural aspects of the carbohydrates due to the work of Professor Haworth and his school at Birmingham. The volume has been thoroughly revised retaining the main features of treatment, which have proved so popular. Thus, attention is confined to natural sugars and their derivatives; glucose is taken as a typical sugar and its properties and reactions considered with particular reference to its biochemical transformations.

Since Fisher's discovery (1893) of the isomeric derivatives of glucose α and β, an enormous volume of work has accumulated on the structure of glucose. Tollen's butylene oxide ring structure was accepted by Fisher.

The discovery of yet a third reactive form, the so-called γ-form by Fisher and Irvine, needed some revision. The remarkable success which attended the work of Haworth, on the structure of the glucose rings, by the well-known methylation method, resulted in giving the amylene oxide structure (1926) to the oxide form of glucose. Conclusive proof has now been adduced to show that the α and β forms are represented by the 1 : 5 Gluco-pyranose structure and the γ-form by the 1 : 4 gluco-furanose structure. The book under review gives a masterly exposition of the structural aspects of the chemistry of sugars.

The present edition dealing with recent work which has resulted in giving some degree of certainty on matters of structure where controversy existed before, will be welcomed by all.

This brief note cannot be concluded without paying a tribute to the authors of the excellent volume. It is very sad to reflect that the demise of the junior author has removed from the field a bright and promising young scientist, thus resulting in an irreparable loss.

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TEXT-BOOK OF BIOLOGY. By E. R. Spratt and A. V. Spratt. (University Tutorial Press Ltd., London.) Price 9*s*. 6*d*.

The study of biology has become more and more a matter of public interest. The Panama canal was as much a victory over the mosquito and those two diseases, yellow fever and malaria, as a feat of engineering skill. The medical student begins his study with a course in biology and medicine is becoming more a question of applied biology and less a mere study of disease. Biological knowledge is found to be more and more indispensable in agriculture and various industries. Civilised society finds biological knowledge to be of great economic and cultural importance. The recognition of the value of biology has led to its being introduced in schools and colleges. Educationists feel that no subject in the school curriculum, except the mother tongue, is of as great a value as biology. And with the introduction of the subject in schools, there has come up a crop of books on biology. Some are of the old general biology type. Some are merely botany and zoology text-books stitched under the same cover. A few, however, are fresh in their treatment, emphasising the point of view of biology, that something is characteristic of *all* living things and that this something is achieved in many different ways. The book under review takes after the traditional method. Function should receive greater emphasis. On this foundation the study of structure should be based. And animal-life and plant-life should form the two dovetailing pieces of one subject. The common forms usually found in books on general biology are dealt with in the greater part of the book. There are some chapters on the physiology of plants and animals. Some account of the ecology of plants and animals is given. A chapter on heredity, variation and evolution is also included. The book may be of use to students who take up biology in the Intermediate Colleges and to medical students.

T. M. S.

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BOTANY PRINCIPLES AND PROBLEMS. By E. W. Sinnott. (McGraw-Hill Book Co., Inc., New York and London.) Third Edition, 1935, pp. xix+525, Price 21*s*. net.

This is a valuable addition to the list of books on Botany for use in Colleges. The book may be divided into two parts. The first few chapters of the earlier part deal with the introductory survey, the history of botany, the cell, the morphology and physiology of the various organs of the plant like the root, leaf and stem. The next two chapters deal with the physiology of metabolism and growth. Then comes an useful and interesting chapter on "Development and Morphogenesis" followed by two chapters on certain aspects of ecology. The special chapters on "Heredity and Variation" and "Plant Evolution" not only provide refreshing changes from the commonly used text-books packed with morphological details but also serve to widen the scope and horizon of the beginner in botany and bring before him the interesting and useful aspects of the subject. A really good book not only catalogues facts but also arouses the interest and curiosity of the student.

In the second part of the book the various groups of the plant kingdom are discussed with the help of a few specific types. It is interesting to note that the vascular plants as a whole have been called Tracheophyta and divided into three broad groups, the Lycopsida, Sphenopsida and Pteropsida. A chapter on primitive vascular plants—Psilophytales has also been rightly included and placed at the beginning of the Tracheophyta. The author opines that the seed-bearing

habit is not the monopoly of the Gymnosperms and Angiosperms which comprised the old group—Spermatophyta. Consequently this term has been discarded altogether.

Reading through the book one however gets an impression that the treatment in the second part of the book has been somewhat rapid. The systematic botany of the Angiosperms may well have been dealt with in greater details and a few families discussed. The Charophyta are better kept as a separate group instead of being wedged in between the Chlorophyceæ and Phæophyceæ; and the number of genera in the Charophyta is certainly not restricted to two as stated on page 379.

The author has within the space at his disposal dealt with the various aspects of botany. The language is clear and direct while the profuse illustrations and excellent get-up of the book leave nothing to be desired. Another valuable feature of this book is the questionnaire at the end of each chapter which not only helps the student to test how much he has assimilated but also helps him to think and to develop gradually the "inquisitive and critical attitude".

A. R. R.

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LES PROBLEMES DE LA RADIOGEOLOGIE. By W. Vernadsky. (Hermann et Cie, Paris, 1935.) 66 pages. Price 15 francs.

This brochure forms number 201 of the series, "Actualités Scientifiques et Industrielles", the geological section of which is published under the direction of M. Lucien Cayeux. The book is based mainly on two lectures delivered by the author at the University of Paris in 1933. In the earlier pages, the author gives a brief résumé of the outstanding contributions to the subject of radio-geology by scientists like Curie, Joly and Strutt. This is followed by a classification of the scope of the subject. The remaining portion of the work is devoted to a discussion of the special problems pertaining to radiogeology, such as the determination of the oldest portions of the earth's crust, calculation of the age of sedimentary rocks, Joly's thermal cycles, thermal heterogeneity of the biosphere, the low temperatures of the ocean, petroliferous beds as fields of radio-chemical phenomena, the migration of uranium lead, the radio-chemical alteration of radio-active minerals, the carbonaceous minerals (tucholite group) discovered in ancient pegmatites, the chemistry of the oldest portions of the earth and the planetary exhalation of helium.

The bibliography is printed in very small type and this is probably the reason for the many typographical errors found in it. The International Table of Radioactive Elements forms a useful appendix to this excellent summary of the subject of radiogeology.

C. S. P.

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INTRODUCTION TO GEOLOGY. By Prof. E. B. Branson and Prof. W. A. Tarr. (McGraw-Hill Book Co., Ltd., New York and London.) Pp. viii+470. 21s. net.

"Introduction to Geology" by Profs. Branson and Tarr forms a useful addition to many of the excellent text-books on the subject which have been published in English. In this book the authors have aimed to present the fundamental principles of Geology in a style simple enough to meet the needs of elementary students who require but an intelligent initiation into a study of the subject.

The book is divided into two parts. Part I deals with physical Geology. Starting with an account of the mode of formation of igneous rocks and their constituent minerals, the processes of weathering and rock decay are described followed by the next four chapters on the earth sculpture as brought about by various denuding agencies. Chapters IX and X deal with sedimentary and metamorphic rocks, and are succeeded by two more chapters on the action of snow, ice and wind. The next three chapters XIII to XV give some account of the structural and dynamical geology, the last one being devoted to earthquakes. Part II deals with historical Geology. A concise statement of the views on the origin of the Earth is followed by a narration of the conditions which existed during different geological periods. Descriptions of the plant and animal fossils of the several formations are given and in addition the economic products found in them are also noted. Chapter XX of this part gives an account of the origin, distribution and methods of locating petroleum.

In spite of the limited scope of treatment of the subject one would have liked to see some account of the coral reefs and the importance of corals as rock builders, included in the book. The presentation of the fundamental principles of any branch of science in a simplified style divested with

much of technical phraseology is no simple matter and unless considerable care is exercised in the selections of suitable terms, loose expressions are likely to creep in which would lead to a misconception of statements. The book under review is not entirely free from a few such faults. The terms lava and magma as used by the authors would have been the better for a clearer definition. At the great depths, mentioned by the authors in page 212, pressure is likely to induce rock flowage and not granulation as stated therein.

Substitution of "conjunction" for "connection" in line 37, p. 211; "does" for "is" in line 9, p. 212; "becomes" for "became" in line 6 (reading from the bottom p. 222) would perhaps make the sense clearer.

The phenomena of re-fusion, density stratification of magmas and igneous intrusions by magmatic stoping are still too controversial to be presented to elementary students as well-established facts.

Despite these few slips, the authors have succeeded in achieving their main purpose, and the book will certainly prove to be a welcome addition and appeal to those readers, who require an elementary knowledge of Geology. It is profusely illustrated with well-chosen photographs and drawings and the general get-up of the volume is all that could be desired.

B. R. R.

* * *

THE WORKING, HEAT TREATING AND WELDING OF STEEL. By H. L. Campbell. (Messrs. Chapman & Hall, Ltd., London.) Pp. 185. Price 11*s*. 6*d*.

The above book is a welcome addition to the large number of treatises already available on the subject of Steel Metallurgy, and should serve as an introduction to the study of different aspects of Steel Metallurgy. It is not usual to find in one book references to the manufacturing processes as well as the shaping, treating and testing of different classes of steel. It is from this point of view that the text-book should be recommended not only to students and apprentices who desire to take up the profession of iron and steel manufacture but also to Managers of industrial establishments who desire to have a general knowledge of all phases of Steel Metallurgy.

The first 3 chapters dealing with various methods of manufacturing steel and the basis on which the steels are classified give all information that is necessary in as brief and intelligible a manner as possible for making a beginning of the study. The author's reference to the High Frequency Furnace shows that all the latest developments in the field of steel making have been kept in view. The physical tests of steel which may perhaps have been dealt with later, deal with only the important tests on the basis of which the qualities of different steels are compared.

The effects of temperature changes and mechanical working of steel form a proper prelude to the next chapter giving a very brief account of different kinds of working steel. The development of steel products from ingots, and the equipment for the manufacture of important classes of steel products such as rails, sections, plates, tubes and axles are brought out very clearly without going into great details which would surely confuse the beginner. Cold rolling which has been playing so prominent a part in the production of quality steel products is given its due importance.

The brief description of the physical constituents of steel with suitable microphotographs of the important constituents in steel is necessary for proper understanding of the heat treatment of steel which plays so important a part in the utilisation of the best qualities that are available in steels; and the equipment required for a proper sized heat treatment shop should serve as a valuable guide to the Engineering or Metallurgical student during his first years of apprenticeship.

Only one chapter for alloy steels and their heat treatment seems rather too brief, considering the varieties of alloy steels in common use and their growing importance in all fields of engineering activities. Even in a small text-book such as the one under review one would like to have more information and data about stainless steels, high speed steels and spring steels.

The extensive use of welding in the construction of engineering structures, automobiles, rail-road cars, etc., fully justifies a detailed description of the principle of welding and the different processes which are in vogue. The concluding chapter describing the various processes adopted for the preservation of steel forms a fit ending for this admirable, though brief, text-book. One should have no hesitation in stating that this book should find a prominent place on the tables of all students of engineering and metallurgy.

A reference to the bibliography on the metallurgy of steel given at the end of the book may not be out of place. From a perusal of the list, one is satisfied that he can get any information, however detailed, relating to the practice of steel making, rolling of different steel products, the treatment of different classes of steel, standards accepted for the various classes of steel, and micrographic study of the constituents of steel. One would have, however, liked to see in this list several valuable contributions from well-known Metallurgists on the Continent and in England.

The laboratory assignments given at the end emphasise the scope of the book, namely, its use as a text-book by technical students.

D. V. KRISHNA RAO.

* * *

COFFEE IN 1931 AND 1932.—Economic and Technical Aspects. (International Institute of Agriculture, Rome.) Pp. 229.

This monograph, published under the auspices of the International Institute of Agriculture, Rome, is the first of the series of monographs on important agricultural subjects which the Institute proposes to publish.

A considerable portion of the monograph is devoted to the economics of coffee production, and over-production, no doubt due to the severe depression the coffee trade is struggling under ever since 1929. Over-production seems to be not so much a result of better yields as of increased acreage under coffee. The phenomenon of over-production is possibly only a temporary one, fostered by the boom years prior to 1929, and, therefore, may be expected to be checked by the lean years that have followed since then. Over-production is not, however, the only problem that faces the coffee grower. Other problems of various and varied interest like soil exhaustion, control of insect pests and fungoid diseases, improvement in quality, improved methods of marketing are all becoming increasingly important and clamour for solution.

These and allied problems form the subject-matter of the latter parts of the monograph. An exhaustive review of work on technical and ecological aspects of coffee growing forms an interesting and instructive chapter to both planters and students alike for study and assimilation. Equally of interest is the chapter on diseases and pests of coffee.

The monograph gains value by the inclusion of a short but instructive chapter on the preparation of coffee in its various stages. This attempt is specially welcome in view of the numerous attempts that are being made all the world over to improve the quality of the berry before it comes into the market. That quantity must give place to quality cannot be too often stressed and it is therefore of particular satisfaction that a monograph on coffee should include and emphasise this point for thoughtful consideration.

The value of the monograph as a reference book, which it is intended to be, is enhanced by the inclusion at the end of each chapter of a fairly exhaustive bibliography of the period which it covers.

The book deals with the years 1931 and 1932, a period during which the depression in the coffee trade first began to be felt seriously. The situation has not improved with the passage of time and with the prices at the level that they are gives little hope of improvement in the near future. It is therefore of obvious importance that a pause should be made in the field of competitive production—nay, over-production—and a stock of the situation taken. The book under review does this in an eminently practical manner and more, adds technical information towards a solution of the various problems that beset both the coffee grower and the trader alike. The book may be consulted with advantage not only by the planter but also by the scientist.

B. N. I.

* * *

INDUSTRIAL POSSIBILITIES OF SOME RESEARCH WORK DONE IN INDIA. By Gilbert J. Fowler, D.SC., F.I.C. (Society of Biological Chemists, India, 1934.) Pp. 42. Price Re. 1.

This neat little publication contains the substance of two lectures delivered by the author at Bangalore under the auspices of the Society. It is very welcome just now, when two Research Organisations have recently been established, one by the Government of India and the other by the Government of Mysore for co-ordinating Industrial Research being pursued at different centres at present.

The first part of the brochure deals with "Researches resulting in permanent factories," particular mention being made of The Sandalwood Oil Factory, Mysore, The Whitelead Syndicate, Bangalore, The Government Soap Factory, Bangalore and the Turpentine Distilleries at Clutterbuckganj

and Jallo. Next part dealing with problems which have been investigated and the results of which await commercial exploitation is of greater interest. Manufacture of Glue as a Cottage Industry and as a subsidiary industry in Tanneries is well worth serious consideration by all interested in a self-sufficient India. Utilization of Molasses is the problem of the day, in view of the large number of Sugar Factories (152) recently started and manufacture of cheap power alcohol should become an accomplished fact very soon; actually, the Mysore Sugar Co., Mandya, have already started the manufacture of cheap alcohol from molasses. The section dealing with small industries requiring very little capital is the most important in the opinion of the reviewer, as the starting of such industries is the only possible means of improving the economic condition of the masses.

By drawing attention to a large number of problems of economic importance to India, Dr. Fowler has done a distinct service to the cause of economic reconstruction in this country. One only hopes that the trouble he has taken will to a small extent at least be repaid by organised research on the new problems and accumulation of useful and practical data.

A very adequate bibliography enhances the usefulness of this important brochure considerably.

K. A. N. R.

* * *

REPORT ON THE SALT INDUSTRY OF RAICHUR AND GULBARGA DISTRICTS. By S. R. Bhate, B.A., B.Sc., with notes by L. S. Krishnamurthy, B.Sc., and Captain L. Munn, O.B.E., M.E. (Bulletin No. 11, Department of Commerce and Industries, H. E. H. the Nizam's Government; Industrial Laboratory.) Pp. 154. Price Rs. 2-8-0.

The publication under review discusses in detail all the sources of salt in Hyderabad which may be classed under the two heads: (1) Salt earth and (2) Saline water. The quality of salt at present manufactured as a cottage industry has been investigated by the analysis of a large number of samples from different localities and useful and necessary data have been accumulated.

The relative merits of pan evaporation and stack evaporation of brine have been investigated and as a result of these investigations the author arrives at the very interesting conclusion that "the advantage of stack evaporation (10′ cube) over solar pan evaporation (10′ square) is 22·5 times". It is therefore suggested that stack evaporation should be adopted and would be a distinct aid to this cottage industry. But one might sound a note of caution that more work is probably necessary before this point could be definitely settled.

The Government Industrial Laboratory, Hyderabad, is doing a distinct service to Indian Industry by publishing reports of the investigations conducted there, but, without any intention of striking a discordant note, it may legitimately be asked whether a price of Rs. 2-8-0 for such publications is not far too high in a country like India where the purchasing power of educated classes is so small.

K. A. N. R.

Forthcoming Event.

IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

September 2nd to 4th, 1935—Meeting of the Governing Council.

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CONTENTS.

The Problem of Malnutrition in India.

THE fact that millions—perhaps the majority—of the people of India suffer from various degrees of malnutrition seems beyond dispute. It is true that more precise data on this question are required—data which can be collected only by dietary surveys, and the systematic physical examination of sections of the population to reveal the incidence of states of malnutrition and deficiency diseases. But sufficient information already exists to prove that malnutrition is widespread. If the diets of the majority of the population, particularly of the poorer classes, are compared, even in a rough qualitative way, with the dietary standards put forward by modern physiologists, it at once becomes apparent that the former fall short of adequacy; in general, they are deficient in the more valuable proteins, and in certain vitamins and mineral salts. Again, food deficiency diseases—beri-beri, certain forms of anæmia, epidemic dropsy, xerophthalmia, etc.—are common throughout most of India. The poor physique and lack of resistance to infection shown by the majority of the population in many parts of the country also suggest that the average Indian diet is a defective one.

It should be realised that this state of affairs is not peculiar to India; that, in fact, the same problem exists in most countries of the world. Outside Western and Central Europe, North America, Australia and New Zealand, and perhaps a few other fortunate countries, the diet of the mass of the population is not very different in quality from that of the poorer classes in India. Thirty or forty years ago, malnutrition and certain food deficiency diseases—*e.g.*, rickets—were very common in England; it is only gradually that the dietary level of the masses is being raised even in the most prosperous countries. To-day China presents a problem of malnutrition which is as formidable as that of India, and there is evidence that other Eastern countries, such as Java, Malaya, and Japan, are in a scarcely more favourable position. The question of malnutrition in South America has been little studied as yet, but quite recently the authorities of one South American country very

remote from India—Chile—have reached the conclusion that dietary deficiency is one of the main causes of ill-health and disease in that country, and are taking steps to investigate and remedy the situation. It may well be that, for a number of reasons connected with religion and climate, the problem of dietary deficiency in India is more difficult of attack than elsewhere, but the difference is one of degree, not of kind. While economists talk of over-production of foodstuffs, the greater part of the world's population would be the better for more food of superior quality to eat.

As regards India itself, the subject of nutrition may conveniently be considered under two heads: research, and the practical application of modern knowledge. More precise data about the dietary habits of the people in different parts of the country are required; these can be obtained only by laborious surveys. In conjunction with such surveys, systematic physical examinations of selected groups should be carried out; apart from general impressions, we have little exact information about the prevalence of states of malnutrition and deficiency disease among urban and rural populations. It would be useful (and simple) to collect in schools data about average height and weight, for each age group, in different races, classes, etc., throughout the various provinces; English and American growth standards are not applicable to India. There are wide gaps in our knowledge of the nutritive values of Indian foodstuffs, particularly as regards vitamins, and mineral salts; steps are already being taken to fill these gaps. Quite apart from such obvious and necessary investigations, there remains a great deal of original clinical and laboratory research to be done on food deficiency disease. In all probability, there are food deficiency diseases in India which have never been observed or described, and even those diseases which are familiar text-book entities might repay further clinical, pathological and epidemiological study.

Certain statistical investigations concerning food supply in relation to population would help to clarify the situation. First a dietary standard reasonably capable of fulfilling the needs of human beings should be chosen, and this diet translated into terms of foodstuffs which can be produced or made easily available in India. Secondly, the food requirements of the population in terms of this adequate diet can be calculated, and a comparison drawn between the national requirements so defined and existing agricultural production and food imports. The fact would probably emerge that existing food production and import fall far short of the point at which such a diet could be supplied. Lastly, the improvements and changes on agriculture and imports necessary to attain this end can be stated in exact figures and subjected to careful analyses. A series of calculations of this nature would provide a solid basis for agricultural (and even fiscal) policy. The resulting figures might not, indeed, be too hopeful; they might clearly show that, in the absence of potentialities for great increase in food production, or of increase in national wealth allowing for food importation on a large scale, there must be a growing disproportion between available food supply and the dietary requirements of an expanding population.

A broad survey of the type outlined may be impossible at the moment owing to the lack of sufficiently accurate data about food values, crop production, livestock, etc. But there is no reason why such information could not be obtained. Bowley and Robertson, in their recent report,[1] have described the defects of existing statistical services and made various suggestions for their reorganisation. Improvement in statistical information would help nutrition research workers to grasp the problem of malnutrition in India as a whole.

Let us turn to the question of practical application, to what may be termed public health nutrition work. Sir Robert McCarrison has repeatedly emphasised the fact that knowledge in this field has already far out-run any efforts towards making use of that knowledge for the benefit of the people of India. Difficulties are enormous. While poverty is the main obstacle, ignorance and prejudice, by no means confined (in India as elsewhere) to the classes which are too poor to have much choice in the matter of food, must play a great part in producing malnutrition. Again, public health nutrition work in India can only develop *pari passu* with public health work of other kinds. But steps could be taken to ensure that nutrition work is given a prominent position in existing public health programmes, and that as time goes on it should receive increasing attention.

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1 A Scheme for an Economic Census of India. New Delhi, 1934.

For this purpose it is essential that emphasis should be laid on nutrition in the training of public health workers of all kinds, including medical officers of health, nurses, health visitors, etc. In some Western countries much practical nutrition work is carried out through the medium of maternity and child welfare centres, health visitors, and the school medical services. As such activities develop in India, opportunities will arise for improving diet by educational and other means.

The question of attaching nutrition specialists to public health departments might receive consideration. Each provincial department might perhaps employ an official with an extensive knowledge of the subject whose duties would be to prepare educational material, to assist in maternity and child welfare work and work in schools, to lecture to medical students, nurses, and subordinate public health officials, to regulate diet in public and residential institutions, etc. All large public health departments in U. S. A. have workers of this kind attached to them. It might be difficult to find men or women qualified to undertake duties of this nature at present in India, but in future provision could be made for their training by various means.

Elementary instruction about diet and food values might be given to the higher grades in the schools, both public and private. The interest taken in McCarrison's book *Food*, and the considerable use that has been made of it in schools, suggest a willingness on the part of school teachers to add this subject to the curriculum. But teachers themselves must first be taught its importance, and a useful line of attack would be through teachers' training colleges. With regard to the education of the public, something might be accomplished by means of suitable press articles, wireless talks, etc. There seems to be an awakening interest in nutrition throughout the country, and the literate classes might respond to intelligently prepared propaganda.

The problem of malnutrition in the village might be approached by selecting small "demonstration" rural areas for intensive work. Data about dietary habits could be collected by careful surveys involving a number of families, and subsequently correlated with the "state of nutrition" of the population group concerned. The exact nature of the deficiencies in the diet would thus be made apparent. The next step would be to attempt to improve nutrition in the "demonstration" area by various means—education and propaganda, maternity and child welfare work, improvement in livestock and agricultural production, etc. The chief aim of a public health nutrition experiment of the type outlined would be to investigate the possibilities of improvement lying within the resources of the people themselves. Results obtained in small areas might have a general application throughout the country.

If the public health side of nutrition work is to develop in the right direction, it is essential that adequately equipped research institutions should exist to provide basic knowledge. Nutrition research is being actively carried on at Coonoor and elsewhere, but there is room for extension of existing institutions working in this field and for the creation of new ones. Sir Robert McCarrison, writing in *Current Science* in July 1932, suggested that "each Presidency or Province should have its own Institute for the study of Nutrition". The activities of the ideal nutrition research institute should include basic scientific research, systematic surveys of foodstuffs, study of cheap well-balanced diets within the means of the poorer classes, field and epidemiological investigations, and a good deal of propaganda and education work. It should have a department for training public health workers of various kinds.

Researches in animal husbandry, nutrition, agriculture, and human nutrition, and efforts to apply in practice the results of scientific research in these fields, are complementary and directed towards the same end. The greatest possible co-operation between those concerned in these activities is desirable.

W. R. AYKROYD.

Planned Prosperity for the Peasant.*

SIR GEORGE SCHUSTER was one of the few Finance Ministers of India who took a comprehensive view of Indian finance and studied it in its larger relation to Indian economic life. Hence his interest in Economic Planning and Economic Councils, which he sought to prepare by inviting to India, two experts to report on the collection of economic statistics in India. In the stimulating lecture he recently delivered before the Royal Society of Arts, Sir George believes, as all those must who have given the problem any serious attention unaffected by prepossessions of one kind or other,—that "the vast masses of the Indian population must be based on rural economy and no conceivable degree of industrialisation can alter this within any period that can be foreseen". It is, therefore, of vital importance to the prosperity of the country that Indian agriculture should take advantage of recent developments in mechanisation of agriculture. But the increasing product of agriculture that will follow must find a sale abroad, but sales abroad are only possible if India will buy industrial goods in return, and a serious obstacle arises in the form of India's own industrial ambitions. If India will not buy from abroad, she cannot sell abroad, and if she cannot sell, her rural population is doomed to continued poverty. The dilemma is resolved, and the interests of a prosperous agriculture with the growth of Indian industrialisation are reconciled by the argument that "there are certain more elaborate forms of industrial products for which the Indian market alone will not give an economic foundation for independent manufacture, and for which India will not, for a long time to come, have the necessary skilled labour and technique"; among such are "motor-cars, telephones, wireless machines, gramaphones, etc." The category exists, though the list may be questioned. India can proceed along her own industrial advance in the direction of production of cotton piece-goods, iron and steel manufactures, sugar, and so on. Thus Sir George Schuster rests Indian prosperity upon the tripod of improved agriculture, increased industrialisation, and imports of goods that India cannot expect to produce for herself in the near future on anything like an economic basis.

People are too often inclined to judge a country's prosperity by reference to figures of production and trade alone, and are either indifferent to problems that affect the standard of the life of the poor or are openly impatient of proposals like Factory and Social Legislation that are calculated to transfer to the workers some share of the gains in production. Sir George is emphatic in his view that "there is a great need for policies which will increase the material wealth of India, but this will be valueless unless they also secure the proper distribution of that wealth, and the greatest need of all is to raise the standard of living of the masses of the people". The problem is how to bring about a higher standard of life, and "somehow or other to get the rural masses of India out of the rut of their present low standards". This can be done partly by Government action and partly, as Sir George Schuster says, by convincing "public opinion of the need and getting all those who have any influence in the villages—landlords, District Councils, Municipalities, Universities, etc.—to work upon it. Mass psychology needs to be moved in the matter."

In view of the recent repudiation of economic planning by the present Finance Minister, it is of much significance that Sir George Schuster reaffirms his faith in economic planning. He holds that "some foresight" is necessary "as to what is to be produced, and an intensive effort to maintain production and presentation for marketing at the highest level of efficiency, so as to produce the best quality at the cheapest price." He believes that "Governments and especially the Government of a country like India, must take thought and give the lead and impetus in these matters". The first duty of the Government, in the absence of "sufficient statistical records" and their interpretation and co-ordination, is to arrange for "a map of its own economic country", and for this purpose a Central Organisation of Economic Intelligence and Statistics must be created. If an intelligent public opinion is to be created, "knowledge must be disseminated". In the light of this emphatic reaffirmation of the need for a scientific and ordered basis of study of economic data for the development of the

* "Indian Economic Life: Past Trends and Future Prospects", by Sir George Schuster: Sir George Birdwood Memorial Lecture, Royal Society of Arts.

country, it is to be hoped that the Government of India will take early steps to give effect to the recommendations of the experts and arrange for an Economic Census of India at an early date, even if the Economic Advisory Organisation recommended by Sir Arthur Salter is to wait till the new Constitution is in operation.

The Baluchistan Earthquake of May 31, 1935.*

By W. D. West,
Geological Survey of India.

THE earthquake which occurred in Baluchistan on May 31st was remarkable in two respects. It was of high intensity at the epicentre, causing great mortality and much damage to property, yet it was felt over a comparatively small area, a little over 100,000 square miles. This is a rather characteristic feature of earthquakes in Baluchistan, and indicates that they must have a shallow focus. The epicentre, where the greatest damage was sustained, extended from the north-west of Quetta to half-way between Mastung and Kalat. Its position is shown on the accompanying map, together with the epicentres of the earthquakes of 1931 and 1909.

Since most of the inhabitants were asleep at the time of the earthquake, little information was forthcoming regarding the beginning of the shock. It so happened, however, that night operations were being carried out that night at a place about 4 miles to the north of Quetta, and it appears from the evidence of those taking part that about 5 to 10 seconds before the main shock started there was a preliminary tremor sufficiently strong to be recognised as an earthquake shock. The main shock came from the south and was accompanied by a noise like the roar of a train in a tunnel. The motion was described by the same observers as being like the action of a small boat in a choppy sea. People in Quetta itself generally described it as a sharp horizontal shake.

The shocks seem to have lasted nearly half a minute. During this time the whole of Quetta City, part of the Civil Lines, the Railway Quarters, the Police Lines and the R. A. F. Lines were laid in ruins. The northern and north-eastern part of Quetta, in which are situated the Cantonment and the Staff College, was much less affected; and although the city must have suffered a shock of almost intensity 10 on the Rossi-Forel Scale, at the Staff College, distant only 3½ miles from the city, the intensity was only 6. In fact, many people living in the Staff College area went back to bed after the earthquake, and were surprised the next morning when, on going towards the city to do their shopping, they found the whole place in ruins. This was almost certainly due to the varying nature of the ground, the area where destruction was greatest being situated on water-logged alluvium, while the Cantonment and the Staff College are situated on dry alluvium.

One striking feature of the earthquake, which caused many people to think that it had a volcanic origin, was the great quantity of dust which arose from the surrounding hills, and specially from Chiltan mountain, both at the time of the main shock and also on the afternoon of June 2nd, when a very severe aftershock occurred. Needless to say the "smoke," which was thought to have been seen ascending from Chiltan, was only dust caused by the collapse of thousands of tons of limestone as a result of the severe shaking which the mountain received.

Another feature of the earthquake which aroused much interest was a line of fissuring in the ground which extended on and off for over 70 miles, from the south side of Chiltan to near Kalat. In places along this line the alluvium was severely fissured, in other places the ground had subsided two or three feet on one side or the other, while elsewhere the ground had heaved up a foot or two. Careful examination of this area, however, showed that the fissuring was purely a surface phenomenon, coinciding with the line of greatest intensity of shock, and it was clear that it did not penetrate the solid rock beneath. Where this line of fissuring crossed the railway line from Quetta to Nushki, the rails were severely crumpled.

* Published with the permission of the Director, Geological Survey of India.

About 100 miles south of Quetta an old mud volcano burst into eruption at the time of the shock, and continued ejecting hot mud for about 9 hours. The term 'mud volcano' is really a misnomer, since it is generally accepted that these phenomena have no connection with true volcanic activity.

In discussing the origin of the earthquake, it is necessary to take into consideration the geological structure of Baluchistan. The general alignment of the mountains is shown very well on the accompanying map, and since the geology and geography are very closely related, in that the axes of the rock folds are parallel to the main mountain ranges, the map also gives an idea of the general geological structure of the country. These folds have been formed by a compression of the rocks in a N. W.—S. E. direction, so that, taking the area as a whole, the folds should be aligned in a N. E.—S. W. direction. This, however, is not the case, and instead the mountains are looped up

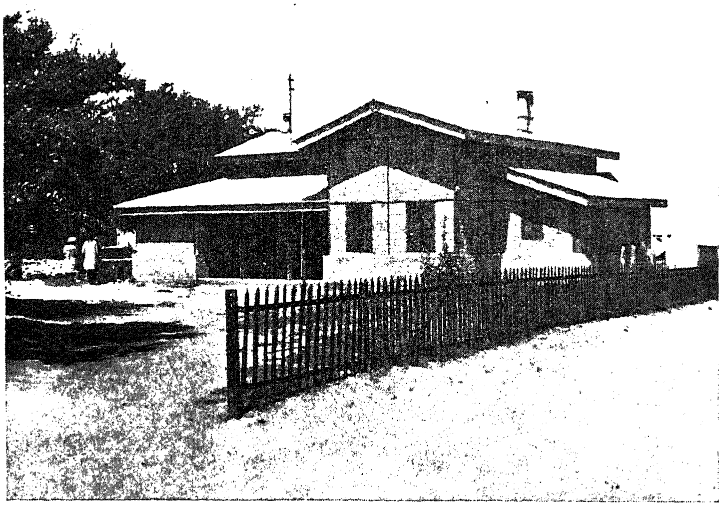
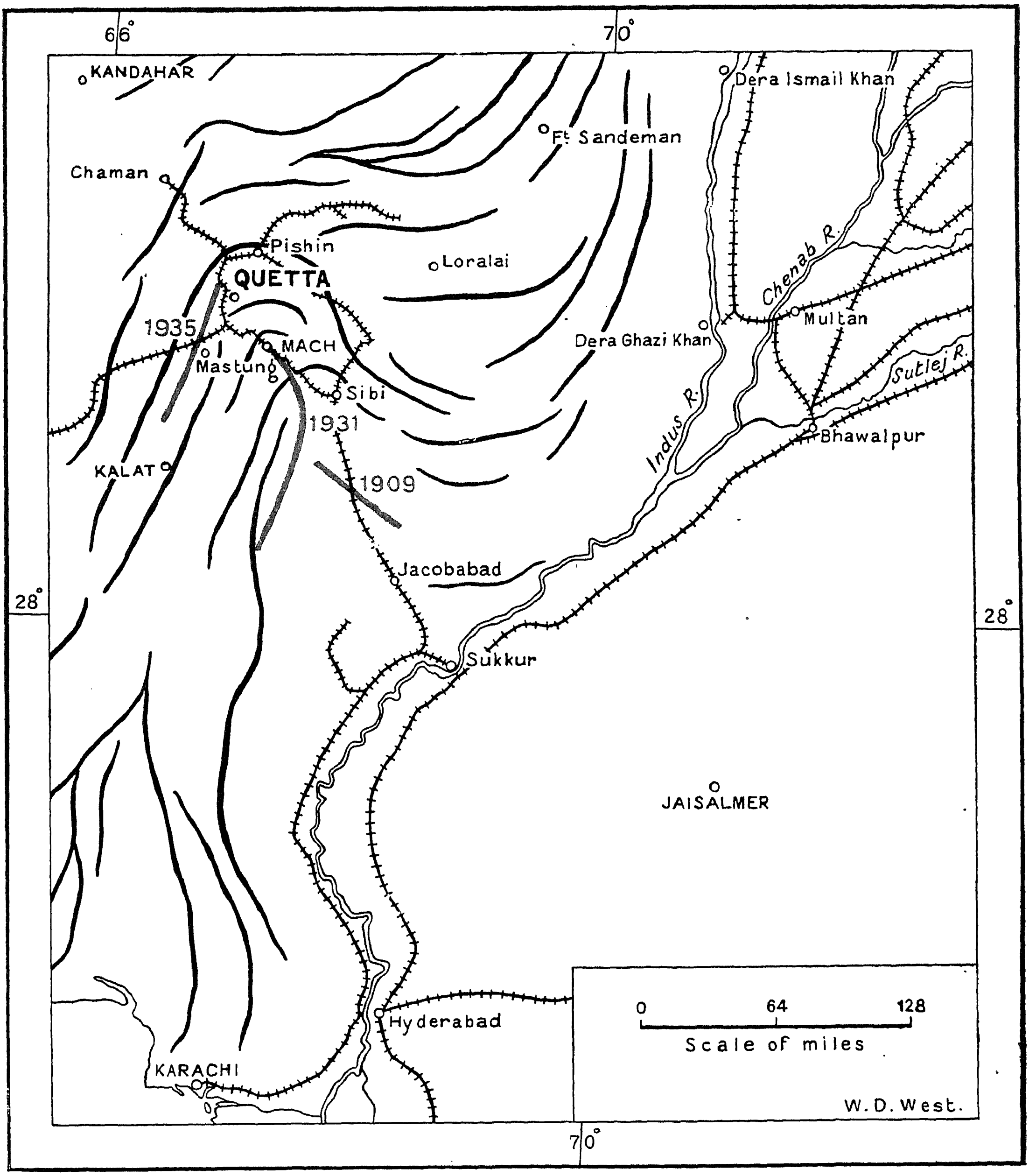


Fig. 1.
An earthquake-proof bungalow built by the North-Western Railway.

Fig. 2.
The Dak Bungalow, Quetta.

to the north-west between Jacobabad and Quetta. Now it is generally accepted that these folds have been formed by the movement of the old stable mass of Central Asia towards the stable mass of Peninsular India, resulting in the compression of the soft marine rocks in between to form the mountains. It is therefore suggested that this sharp deflection in the alignment has been caused by some underground obstacle



MAP OF BALUCHISTAN AND SIND, SHOWING THE ALIGNMENT OF THE MOUNTAINS AND THE EPICENTRES OF THE LAST THREE EARTHQUAKES.

which is obscured from view by the alluvium of the Indus valley, and which has prevented the free movement of the folds towards the south-east. The effect may be likened to the waves of the sea, when they are deflected in their course towards the shore by the obstruction of a breakwater. The waves flow freely on either side, but are held up by the break-water. Whether or not this hypothesis is correct, it is a fact that the geology around Quetta is more complicated than it is in any other part of Baluchistan, and the rocks have yielded here not only by folding but also by fracture. It is around this re-entrant angle that the greatest strain must occur, and it is here that one would expect most earthquakes to originate. In actual fact this is the case, and most of the severe earthquakes which have visited Baluchistan have been confined to an area within a radius of about 150 miles of Mastung.

In the case of the last three severe earthquakes which have visited Baluchistan, namely those of 1909, 1931 and 1935, the epicentres of which are shown on the map, no connection could be traced between the location of the epicentres and any known fault. It therefore seems clear that the earthquake, if it was due to movement along a fault, must have been connected with some fault which does not reach the surface of the ground.

The enormous death roll which occurred at Quetta is directly attributable to the very poor manner in which nearly all the buildings were constructed. Owing to the scanty rainfall in this part of India, it has been the practice in the past to use a mud mortar. Such a mortar has very little bonding power, and when an earthquake occurs, the very heavy lateral force to which the building is subjected simply causes the bricks to slide over one another, and the building collapses. In the case of the present earthquake a feature of great interest was provided by certain North-Western Railway bungalows which had been built since the 1931 earthquake and had been designed on earthquake-proof lines. Although surrounded by smashed buildings, they are without a single crack. The accompanying photographs show the completely ruined Dak bungalow in Lytton Road and one of the new earthquake-proof Railway bungalows situated on the other side of the road. It is difficult to imagine a more striking illustration of the efficacy of sound earthquake-proof construction, in which rigidity has been the main consideration. By making a building as rigid as possible, instead of the building falling apart during an earthquake, due to the different parts of the building behaving differently, it will move as a whole and so avoid being cracked. That these Railway bungalows did move as a whole was clearly shown by the fact that those who were living in them were so severely shaken that they were unable to stand up inside the bungalow during the earthquake, while heavy almirahs were also thrown down. These bungalows had been made rigid by bracing with vertical and horizontal iron rails, and had been constructed to withstand a horizontal acceleration of 3·2 feet per second per second. From this, however, it is not to be inferred that the acceleration of the earthquake motion was less than 3·2 feet per second per second, because in constructional work a considerable factor of safety is always allowed, which may be as much as 3 or 4.

It will be seen from the map that the centre of earthquake activity has gradually moved north-westwards since 1909. It is doubtful, however, if any conclusion regarding the location of the next earthquake can be inferred from this. Such knowledge as we have of previous earthquakes, in Baluchistan shows that they jump about from place to place in accordance with no apparent law. If, however, an earthquake be regarded as affording relief to the strains which have accumulated in the rocks, then it may be fairly safely predicted that the next earthquake, when it occurs, will not be located along the same line as the present one.

The Pre-Vindhyan Geology of Rajputana.

By A. M. Heron,
*Geological Survey of India.**

SINCE 1907 a geological survey of Rajputana and the States of Bombay which adjoin it to the south in Gujarat has been in progress. Its results have been presented from time to time in papers by the author and his colleagues Mr. C. S. Middlemiss, Dr. A. L. Coulson and Mr. B. C. Gupta, and several other publications are in preparation. As, however, it may be some time before the main description dealing with the work done in central Rajputana since the Great War can appear, it has been thought advisable to submit a brief sketch of the results obtained. A somewhat fuller account of this has appeared in the *Transactions of the National Institute of Sciences of India*, Vol. I, No. 2.

The rocks below the Vindhyans and the Malani volcanics have been arranged in four groups, separated by three erosion unconformities, all of which are in places clearly shown by basement conglomerates accompanied by other evidences of discordance, and are in addition well displayed in the mapping by the trend of the boundaries of the formations. The unconformity most distinctly seen, that at the base of the Delhi system, has been traced for something like five hundred miles along the edges of the synclinorium, which is almost exactly coincident with the limits of the Delhi system, for outside of it representatives of the Delhis are insignificant and somewhat uncertain. It appears to have been the successor to a geosyncline in which the Delhis were accumulated; on either side of it are found the older formations—the Raialo series, the Aravalli system and the pre-Aravalli gneisses.

The succession is shown in the annexed table.

In view of the presence in Rajputana of four distinct Precambrian and Archæan formations, separated by important unconformities each denoting a period of diastrophism and erosion, and of the immense thicknesses of strata involved, it is reasonable to infer that the Bundelkhand gneiss and the banded gneissic complex at the base of this long sequence are among the oldest rocks which occur anywhere upon the earth's surface. If the Vindhyans are also placed in the Precambrian, neglecting the doubtful evidence of obscure markings which are held by some palæontologists to be primitive Cambridge brachiopods and by others to be vegetable remains, the sequence is still further lengthened and the oldest rocks are pushed farther down in the Archæan.

Unfortunately we can say nothing definite regarding the relationship of the banded gneissic complex and the Bundelkhand gneiss, as their mutual junction is everywhere concealed by a broad syncline of Aravallis resting on both of them unconformably. In a recent paper in *Current Science*[1] by Mr. W. D. West, it is stated that they are thought to be equivalent. This, however, is the case only in the sense that both are overlain unconformably by the Aravallis, for they are entirely different lithologically. The Bundelkhand gneiss is a true granite, unfoliated except in its extreme western extension, non-porphyritic, and remarkably uniform over all its wide area of outcrop; it is traversed by intrusive dykes of dolerite and great reefs of quartz. The banded gneissic complex, on the other hand, was originally a sedimentary formation, predominantly argillaceous, but showing by two anticlinal inliers of massive bedded quartzites that its oldest visible strata were arenaceous. Over most of its extent, however, especially in the south, its sedimentary character has been obscured by the intrusion of multitudes of acid and basic rocks in great variety of texture and of different ages, giving rise to a complex of banded and foliated gneisses. In the north the banded character is on the whole less strongly marked and the intrusions are more in the form of large bosses of a dark porphyritic biotitic granite, usually strongly foliated, with its cognate pegmatite and aplite veins forming composite gneisses, and masses of basic rocks.

To the north-west of the synclinorium a third type of gneiss, a fine-grained and usually homogeneous granite, is present at

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[1] *Current Science*, 1934, 3, 138.

Jodhpur. Memoir, Geological Survey of India, XXXV, Pt 1. Records, Geological Survey of India, LXV, Pt. 4.		*Mewar, Ajmer-Merwara* (Main Syncline).	Unmetamorphosed rocks of *Chitor, Nimbahera* and *Sadr.*			*Jaipur.* Records, Geological Survey of India, XLVIII, Pt. 4 and LIV, Pt. 4.	*Alwar.* (North-Eastern Rajputana), Memoir, Geological Survey of India, XLV, Pt. 1.
Vindhyans of Western Rajputana.			Upper Vindhyans. 'Semri Series' (Lower Vindhyans).				
Malani volcanic series.	*Delhi System.*	'Calc-gneisses.' 'Calc-schists.' Biotite-schists.				Ajabgarh series.	Ajabgarh series. Hornstone breccia. Kushalgarh limestone.
	Delhi System.	Quartzites. Basement arkose grits.	Sawa shales and grit.	Fault	Jiran. sandstone	Alwar series.	Alwar series.
Raialo (Makrana) marble, limestones of Ras. Unconformity not seen.	*Raialo Series.*	Garnetiferous biotite schists. Raialo (Rajanagar) marble. Local basal grit.	Raialo (Bhagwanpura) limestone.	Boundary			Raialo limestone. Raialo quartzite.
Shales (Sojat). Schists of Godwar. Unconformity not seen.	*Aravalli System.*	Phyllites, cherty limestones, quartzites and composite gneisses. Basal quartzites, grits and local conglomerates. Local thick volcanic series.	Khardeola and Kanoj grits, Badesar quartzites. Vague unconformity. Ranthambhor quartzites. Shales and cherty limestones. Basal quartzites and grits.	Great	Binota shales.	Quartzites and schists of Baonli—Awan ridge and Bechun, Biana and Lalsot hills. Volcanics of Basi. Schists of Rajmahal.	Limestones and schists of Baswa and Rajgarh. Quartzite and conglomerate of Rewasa.
Grey homogeneous gneiss.		Banded gneissic complex.	Bundelkhand gneiss.			Gneissic granite of Karela and Ganor.	

the edge of the Marwar plain, but is much obscured by the Erinpura granite intrusive in it, and by alluvium. It is clearly older than the Delhis but the Aravallis have not been seen in association with it.

The Aravalli system consists predominantly of an immense but immeasurable thickness of phyllites, in certain zones of which impure limestones and fine-grained quartzites occur. Its base is marked by a thin grit resting on the underlying gneisses, and in two widely separated areas thick basic amygdaloids and pyroclastics have been accumulated near the base, in one case passing up into a great series of conglomerates, and these again into massive quartzites.

A feature of great interest is the occurrence, south of Chitor in south-eastern Mewar, of a tract in which the Aravallis have undergone hardly any metamorphism, being still shales with low rolling dips. As they are followed across the strike from east to west, in the direction of the ancient belt of mountain-folding and igneous intrusion of the synclinorium, dips steepen and they become successively slates, phyllites and ultimately mica-schists with small garnets, magnetite, staurolite, chiastolite and kyanite. The intruded dolerite becomes epidiorite and hornblende-schist.

At the top of the little-altered Aravallis are several quartzite and grit formations, of very limited extent and somewhat obscure relationships, to which have been given local names. Some of them (the Badesar quartzites, the Kanoj and Khardeola grits) appear to be slightly unconformable upon the Aravallis; others, the Ranthambhor quartzites, which are found in eastern Jaipur as well as in south-eastern Mewar, are conformable with the Aravallis.

The suggestion is made that the Gwaliors may also be unaltered Aravallis, like those just mentioned, which, like them, have escaped metamorphism owing to their distance from the protaxis of diastrophism now represented by the Aravalli range and by the protection of the solid mass of Bundelkhand gneiss upon which they rest.

Intrusive igneous rocks in the Aravallis are scarcer than in the pre-Aravalli gneisses and in the Delhi system. In the unaltered Aravallis they comprise the dolerite mentioned above, which may perhaps be the hypabyssal equivalent of the Khairmalia amygdaloid at the base of the Khardeola grits, and in the metamorphosed Aravallis to the west they are granite and ultra-basic rocks. The granite, acid, fine-grained and almost devoid of mica, forms several bosses near Udaipur City; on their margins intrusive relations with the Aravalli limestones are excellently shown, and the granite, by *lit-par-lit* injection of the mica-schists, gives rise to a broad band of composite gneiss which runs south-east from Udaipur City[2] for many miles. The ultra-basics are talc-serpentine-chlorite rocks occurring near Rakhab Deo[3] and at other places. The post-Delhi Erinpura granite also invades the Aravallis south-east of Salumbar.

The Raialo series is the thinnest and simplest of the four formations discussed, consisting of a thin, occasionally conglomeratic quartzite at the base, which, however, is more often than not missing, then about two thousand feet of white crystalline limestone, with at the top of the sequence but exposed in one area only, in the core of the syncline (see below) near Kankroli, an unknown thickness of garnetiferous biotite-schist.

A correlation has been made between the widely separated exposures of massive white crystalline limestone which are believed to belong to this series, near Raialo on the frontier between Jaipur and Alwar States, a great syncline running out from below the base of the Delhis past Nathdwara and Kankroli and extending as long narrow synclinal outliers beyond Bhilwara to the Jahazpur and Sawar hills near Deoli, the celebrated Makrana marble in Jodhpur State, with other outcrops along the strike to the south-west and, in the south-eastern Mewar area of unaltered Aravallis, the "Bhagwanpura limestone". In the Makrana and other occurrences to the north-west of the Delhi synclinorium the limestone is a calcium carbonate rock, in those to the south-east of the synclinorium it is dolomite.

The limestone is very free from igneous intrusions, only a few dykes of the post-Delhi pegmatite penetrating it, but the garnetiferous biotite-schists which overlie it give excellent examples of how various types of gneiss arise from the injection of one original rock. Starting from biotite-schist intruded by large definite dykes of pegmatite, these may become so numerous that they crowd into each other leaving little schist, or they may take the form of

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[2] *Mem. Geol. Surv. India*, 1934, **65**, pt. 2, 152-153.

[3] *Rec. Geol. Surv. India*, 1933, **65**, pt. 4, 453.

clusters of sills, ending in the schist being intimately and uniformly permeated by multitudinous interfoliar veins, forming a banded composite gneiss often highly contorted. There is no evidence that the Raialos were invaded by any igneous rocks of post-Raialo but pre-Delhi age.

The rocks of the Delhi system are exposed in a great synclinorium which extends throughout Rajputana from north-east to south-west, disappearing beneath the Indo-Gangetic alluvium at the one end at Delhi, and under the alluvium of the Gujarat plain at the other, in Idar State. The north-western flank of the synclinorium is a straight line but its south-eastern side is a great curve; in the medial portion of this, for about forty miles along its length, the synclinorium is a simple syncline about six miles wide but to north and south of this it widens greatly by the development of numerous isoclinal folds.

In the southern portion the base of the Delhi system is exposed as a simple curve without re-entrants, as the present surface of erosion cuts only the higher portions of the folds and therefore the upper formations only, in the synclinorium itself. In the northern portion, however, the basal beds are repeated in great curves running athwart the general direction of the axes of folding, the anticlines pitching to the north-east. We find that the uppermost divisions of the Delhi sequence are more fully preserved in the southern part of the synclinorium than in the northern.

South-west of Ajmer the synclinorium consists of two synclines of Delhis separated by a tongue of the pre-Aravalli banded gneissic complex. They are brought together to the south-west by a thrust-fault, and beyond their point of meeting the north-western of the two synclines is so much intruded by epidiorite and Erinpura granite that it is ultimately obliterated at about where the other, south-eastern, syncline becomes the sole component fold of the synclinorium and so persists, as I have said, for a distance of about forty miles along its length, with a breadth of some six miles. This decrease in width is in part due to the smoothing out of minor folds and in part to the Alwar series at the base of the Delhis having almost died out for a space, to reappear again to the south.

South of the constriction the synclinorium widens again owing to additional folds appearing, to the coming in again of the Alwar series in force and also to deeper plunging synclines bringing in the highest beds of the central core. Here also igneous intrusion, principally the Erinpura granite, increases towards the south-west, obliterating the component formations *en echelon* from west to east until in Idar State only the Alwar quartzites are left where the synclinorium disappears below the alluvium of Gujarat.

In the northern part of the synclinorium both the strong quartzites and the basement grits of the Alwar series are in force, the latter becoming coarse conglomerates with strangely flattened and elongated cobbles at Barr and Srinagar. As a rule the basement beds here are arkose, the felspar being derived from the abundant granitic material in the pre-Aravalli gneisses upon which they rest unconformably.

South of the constriction the basement beds of the main synclinorium are fine-grained quartzites with intercalations of biotite-schist, as they are derived from the underlying Aravalli phyllites, which yield on disintegration no coarse felspar and no pebbles. Out to the east, however, is a line of faulted outliers of the Alwar series, in which arkose conglomeratic grits are strongly developed, as they rest upon the granite-intruded pre-Aravalli gneisses.

The Kushalgarh limestone[4] and the closely associated Hornstone Breccia, which in Alwar State separate the Alwar series from the Ajabgarh series, are not found outside Alwar.

In the country now described, *i.e.*, from the Sambhar Lake southwards, the lowest division of the Ajabgarhs is typically a great thickness of biotite-schists intruded with pegmatite in massive dykes and sills, and with aplite in veins and *lit-par-lit* injection; as a rule there is as much igneous material present as sedimentary, and excellent examples are seen of the transition from phyllite through biotite-schist to composite gneiss formed by the interfoliar permeation of biotite-schist with aplite.

The middle division, the "calc-schists," in their least metamorphosed phase are calcareous shales and impure limestones, seen only in two narrow synclines folded into the Alwar quartzites in the extreme south. These form the Mundeti series[5] of Middlemiss. Except in these two narrow

[4] *Mem. Geol. Surv. India*, **1917**, **45**, pt. 1, 56-72.

[5] *Mem. Geol. Surv. India*, **1921**, **44**, pt. 1, 53-61.

synclines and the isolated exposures of the "Mundeti series" in Idar, the "calc-schists" attain a higher degree of metamorphism, and have a surprisingly uniform character throughout their great length of outcrop. They are straightly banded, flaggy rocks, the banding being certainly the result of the original stratification and is now due to the alternation of dark layers rich in biotite and actinolite with pale layers of felspars, tremolite and diopside. The amount of igneous intrusion is generally less than in the case of the biotite-schists, and it occurs more as large sills and dykes of pegmatite, *lit-par-lit* injection being scarce.

The upper division of the Ajabgarhs, the "calc-gneisses," in its less altered phase in the north-east is a series of dark, banded biotitic and siliceous limestones, passing gradually along the strike to the south-west into "calc-gneisses". In these the banding, which is essentially the same as the banding in the original limestones, is broader and more variable in composition and in width than in the "calc-schists" and is more irregular, often being characterised by extraordinary contortion. In the "calc-gneisses" bands composed largely of carbonates (calcite and dolomite) alternate with bands rich in silicates (felspars, diopsides and amphiboles), the former being more soluble than the latter, which stand out in relief on weathering. In both "calc-schists" and "calc-gneisses" the present banding is essentially the same as the original stratification but metamorphosed; this consisted of alternating layers of calcareous sediment with argillaceous and ferruginous sediment.

The earliest intrusives in the Delhi system are epidiorites and hornblende-schists, originally basalts and monzonites, which are in particular abundance along the north-western flank of the synclinorium. Ultra-basic rocks are represented by talc- and chlorite-schists and by a group of small plugs of unfoliated talc-limonite-serpentine-magnesite rock, probably much younger than the former schists.

The principal post-Delhi intrusive is the Erinpura granite, in bodies of all sizes, and with wide variations of texture and degree of foliation. Its earliest forms were probably aplite veins and foliated granite sheets, followed by stocks and batholiths of larger sizes, composed of granite coarser in grain, more biotitic and often unfoliated; the last manifestation was the widespread pegmatite swarms.

Later than the Erinpura granite and earlier than the Malani volcanic series is a suite of basic and ultra-basic rocks found by Coulson[6] in Sirohi State, comprising picrite, pyroxenite, gabbro, dolerite and basalt. It also includes a sodalite-syenite; this is quite distinct from the soda-syenites[7] of Kishengarh State at the other end of the Aravalli range, which are probably pre-Delhi in age.

The Jalor and Siwana granites with their granophyres, porphyries and rhyolites, form the Malani series,[8,9] which has a wide development on the plains to the west of the synclinorium. The Idar granite of Middlemiss,[10] which was formerly supposed to be the same as the Jalor and Siwana (Malani) granites, has at the end of this field-season been traced into continuity with the main Abu-Erinpura batholith of the Erinpura granite, and the outcrops of the Malani series are thus confined to the west of the synclinorium and the Aravalli range.

Youngest of all is the dolerite which cuts the Delhis and the Malanis in a few plugs and dykes and may perhaps be related to a dolerite which intrudes even the Semri series or Lower Vindhyans far to the east in Mirzapur district.[11]

The Delhi system is characterised by a greater variety and abundance of igneous intrusives than either the Aravalli system or the Raialo series and by the fact that its sedimentary rocks usually attain a higher grade of metamorphism, particularly in the south-western part of the synclinorium, than the much older Aravallis outside it. It is believed that the plethora of intrusions was not to any important degree the *cause* of metamorphism but that the rocks of the synclinorium had reached their present metamorphic stage before the almost universal pegmatite, at any rate, had pervaded them. The Erinpura granite has, it is true, in some places produced local extra metamorphic effects on the calc-gneisses, but both calc-gneisses and calc-schists are uniformly in their usual highly metamorphosed

[6] *Mem. Geol. Surv. India*, 1933, **63**, pt. 1. 77-101.
[7] *Rec. Geol. Surv. India*, 1924, **56**, pt. 2, 179-197.
[8] *Mem. Geol. Surv. India*, 1902, **35**, pt. 1, 19-25.
[9] *Mem. Geol. Surv. India*, 1933, **63**, pt. 1, 102-141.
[10] *Mem. Geol. Surv. India*, 1921, **44**, pt. 1, 115-126.
[11] *Mem. Geol. Surv. India*, 1933, **62**, pt. 2, 191-193.

state over great areas and at great distances from any body of Erinpura granite.

Pegmatite veins were never seen to produce any marginal effects on the calc-gneisses and calc-schists, and in considerable areas free from pegmatite they do not differ from those in tracts riddled with pegmatite. Though not cause and effect, igneous intrusion and metamorphism are doubtless related in both being effects of the same cause,—deep folding by which the rocks were brought within the range of high temperatures and pressures and into contact with rising granite magma.

The Delhis appear to have been deposited in a geosyncline which was subsequently laterally compressed and elevated into a mountain range, the deeply folded roots of which are now laid bare. The two major unconformities, at the base of the Aravallis and at the bases of the Delhis and Raialos respectively, were of sufficient magnitude for the underlying formations to be highly folded and for deep-seated plutonic masses to be laid open by denudation. In the Raialo-Delhi interval similar folding took place but no post-Raialo and pre-Delhi igneous rocks have been detected.

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Additions to the London Zoo.

We learn that the Prince of Wales presented to the mammalian section of the London zoo a giraffe-like specimen commonly known as the Okapi. This animal is known to the zoologists from a long time and we read that Sir, H. Johnston made a present of the skin, two skulls and the bones of the feet of a new genus of Giraffidæ secured from the Belgian Congo to the Nat. Hist. Society, London, as early as 1900. On examination this turned out to be the new genus *Ocapia johnstoni.* The genus *Ocapia* contains a single species *O. johnstoni.* Peculiarly, however, the animal which is about the size of a Sable antelope, incorporates in itself the striped side skin of the Zebra on its hind and forelimbs and the head of the giraffe *minus* the horns. The body and tail are coloured uniformly reddish brown. Naturalists tell us that he is a very shy creature and exhibits a predilection for choosing the thick recessus of the forests, but always lives in pairs. As regards the position of the animal in the scale of evolution, we know from the study of the skull that it is intermediate between that of the giraffe and that of the extinct Samotherium of the lower Pliocene of Europe.

The rare and proverbial blood-sucking bat—the Vampire—is a native of tropical America. Though small in size, it possesses a sharp set of teeth by means of which it is capable of inflicting painless wounds and then "licks" the oozing blood by means of the tongue with such rapidity that a regular sanguinous stream is seen to enter the mouth. For a long time the use of the long thumb was not known and now after a careful study Ditmar tells that it is used as feet for progression on the ground.

Wood Preservation in India.

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In spite of all the efficient salesmanship and propaganda of cement and steel interests in India, wood is still very widely used for construction purposes. At the same time, for some years, wood has been gradually losing ground as a structural material. When timber was more plentiful, and steel and cement were less easily available and were more expensive, the urge for its proper use was not so apparent. In these days of competition, wood is used only in places and for purposes where it is not only initially less expensive than steel and cement, but where it is also cheaper in the long run. If a much longer life than what can be obtained with most raw untreated timbers of India cannot be secured, wood will be rapidly ousted out of the structural field. It is this aspect that brings us face to face with wood preservation by the application of physical and chemical principles. Naturally non-durable wood has to hold its own not only against non-cellulosic structural materials that are available in the market, but against the more naturally durable timbers.

A tree saved is a tree grown. It is wood preservation that makes one tree serve the purpose of even four or five trees, as with most Indian timbers, wood preservation augments the life by 400 to 500 per cent. Hence the wood preserver is not only aiding forestry, but is making forestry pay by the conservation of forest resources, and by the elimination of waste to a minimum.

What is a handicap with raw untreated timber becomes an asset when once wood preservation is employed. The so-called "katcha" timber for which people hardly pay anything in the timber-yard at present becomes very much more valuable than the expensive heartwood when once it is chemically preserved, as being almost invariably much more porous, it absorbs more preservative and to a greater depth. The aristocratic position held by the naturally durable timbers like teak and deodar in India is due to a poison with which they are endowed by Nature. In a scientific age like the present, tables have been turned by creative chemistry against a number of natural materials by superior and artificial materials that are more suitable and efficient for coping with certain specific conditions encountered in practice. When once timber is submitted to modern wood preservation processing, most of the porous timber that is despised and rejected at present will be more valuable than the so-called hard and durable timbers which cannot be filled up by impregnation with fire-proofing chemicals, dyes, etc. While the ordinarily despised pine can be fire-proofed, teak cannot be.

There are in the Indian forests several woods that are mechanically strong for almost any structural purpose, and stronger than pine and fir which have been widely employed for even railway bridge construction in the United States of America and Canada, but owing to their want of resistance to white ant and fungus attack, they are not used for construction work. In some cases, wood has got a bad name by its having been used unwisely. It can give only a short life if not chemically preserved. The same is the case with leather. Raw hides perish very much more rapidly than tanned skins. Unpainted or ungalvanised steel or iron perishes rapidly in a moist climate. Even cement concrete, unless special chemicals are included and unless properly made and cured, cracks under frost, and the cement is dissolved out if it is in contact with water for several years. Even the best of structural materials requires some kind of protective chemical treatment for resisting the disintegrating forces of Nature.

Besides fire, the two most important agents that tend to destroy wood, especially structural timber during service, are wood-boring insects and fungi. As iron and stone disintegrate through inorganic processes, unprotected wood is destroyed through decay. It is only Nature's cycle of creation and destruction that is incessantly going on. Decay is caused by low forms of plant life which, being incapable of photo-synthesis, feed on carbohydrates that have already been formed and are available. They produce an acid that dissolves organic substances, facilitating assimilation. The four requirements for the growth of fungi are oxygen, moisture, a favourable temperature and food. When submerged in water, or in the earth below the " level of water of saturation", wood has been known to last hundreds of years. In perfectly dry

situations, it is not affected by fungus for an almost indefinite period. A damp condition, accompanied by poor ventilation, offers very favourable conditions for fungus attack. It is for this reason that timber fence posts and joints, where water tends to stagnate, etc., decay rapidly. Wood destroying fungi cannot grow at very high or very low temperatures. There is hardly any wood destroying fungus that can live above 40° C. while very few can live below 15° C. Most fungi—especially the so-called "wet" fungi like *Coniophora cerebella*—grow vigorously between 20°C. and 25° C. A few of the so-called dry fungi like *Lenzites thermophila*, which attack the tops of poles and posts, thrive vigorously between 30° C. and 35° C.

The wood itself supplies the fourth requirement—namely food. It is interesting to note that some fungi attack only the cellulose component of wood while others the lignin component.

To prevent fungus attack, it is obviously necessary to deprive it of one or more of the four above mentioned requirements. In all outside locations and in most indoor locations, it is impossible to deprive them of air, or to keep them at a very high or very low temperature. The best and most practicable way is, therefore, to poison the food supply. This is the principle on which successful wood preservatives are based.

Wood-boring insects, including white ants, attack timber almost irrespective of its moisture condition, although a certain minimum moisture content in wood appears to induce insect attack more readily. The action of wood preservatives on wood-boring insects is similar to that on fungi which cannot feed on poisoned wood without being killed.

Modern wood preservative treatment performs three kinds of service. Firstly, it increases the durability life of wood by over two or three decades even on exposure to very severe conditions saving several times the cost of replacing the structure, and the inconvenience involved in such frequent renewals. Secondly, it makes the present worthless sapwood even more durable than the heartwood of even the most naturally durable species. This removes the necessity for imposing restrictions on sapwood content and distribution in structural timbers. It, therefore, permits closer utilisation. Thirdly and lastly, it enables our so-called junglewoods and poles in the round, which are invariably of low natural durability,
used widely for construction purpose

A successful wood preservative sho
toxic enough to kill wood-boring inse
well as fungi. It must be available in
quantities and be of uniform compo
It should be also not high-priced. Als
preservative should neither volatilis
get washed out from wood when ex
either to running water or to moist soi

There are several wood preservatives
market to-day. The Forest Research
tute, Dehra Dun, has tested several
wood preservatives against fungus and
ants during the last about 25 years.
of the preservatives that were tested
good results for the first year or so
owing to either volatilisation or lea
the treated specimens of wood comm
to fail rapidly after that period.

Generally speaking, there are two kin
wood preservatives. One kind is repres
by oils like coal tar creosote. Such pres
tives are almost insoluble in water, but te
volatilise. Coal tar creosote has given
lent results as a wood preservative, b
very expensive in India besides giving
a pungent odour. The other class consis
water-soluble salts. These are very u
for outside moist locations only if they
be "fixed" to wood. Five of the
important inorganic elements that
been employed with success in the past
zinc, fluorine, mercury, copper and ars
The first two elements have not been f
to be very effective against white ants, v
proving efficient against fungi. They
therefore, almost useless for Indian co
tions. The mercury wood preservativ
too expensive compared to the remai
four, and also cannot be employed
pressure impregnation in steel cylin
Therefore, our choice falls on copper or
arsenic.

On account of wide variations in temp
ture and humidity in India, wood, alm
invariably, splits under service condit
so that as deep a penetration of the prese
tive as possible should be secured if trea
wood is to give efficient service in out
locations. This necessitates a pressure
pregnation. The most recent experie
in India and abroad has demonstrated
for a unit of money, an optimum comb
tion of copper and arsenic affords the m
efficient protection to wood against w
ants and fungi. Such a preservative, to
successful, should not only be easily sol

in water, but while forming a compound in wood that is almost insoluble in water, like limestone, the compound should be soluble to form a lethal dose, in a very dilute acid of a pH-ion concentration of between 4 and 5, an acidity corresponding to that produced by wood destroying fungi when they attack and assimilate wood substances in Nature. It may be stated that the acidity corresponds to about $\frac{1}{3}$ per cent. concentration of concentrated acetic acid in water. The preservative should not only be stable in contact with steel and cement, but should not corrode steel. A successful wood preservative satisfying all the above conditions was recently developed by the writer at the Forest Research Institute, Dehra Dun. It is called *Ascu*.

The next aspect that merits consideration is the method of applying wood preservatives. Generally speaking, there are three methods. The preservative may be either impregnated under mechanical pressure, or be introduced into wood by allowing it to soak for several hours in the preservative fluid. A third method of application is either with a brush, or a spray pump. Where timber is employed in sheltered locations, if it has been well air-seasoned to start with, it can be treated with success either by soaking or brush-painting. For use in outside locations as with railway sleepers, especially when timber is partially buried in the earth, as in the case of a pole or post, it should be pressure-treated for obtaining the best results. Otherwise, timber splits and cracks. The planes of cleavage thus formed will serve as channels for the ingress of white ants and wood destroying fungi spores.

From the point of view of distribution and content of preservative fluid in wood cells, there are two general methods of wood preservative impregnation, one is the "full-cell" impregnation in which the cells, after displacing the air in them, are filled by the preservative fluid. In the "empty cell" processes—the second general method—wood cells are only lined with a coating of the preservative so that by employing them, a considerable saving in the cost of preservation results. Up to about 80 to 90 per cent. of the preservative originally introduced under pressure can be recovered. Each method has got its own field of application. While in the "full-cell" processes, exposing the timber to a vacuum, or boiling it in a vacuum are the common lines of procedure; in the "empty-cell" processes, either the air that is contained in wood is compressed by superimposed hydraulic pressure, or air from outside is injected under pressure into wood before the antiseptic fluid is forced so that a high pneumatic pressure is, initially, created in the wood. When the superimposed hydraulic pressure is broken, compressed air inside the wood comes out rapidly bringing with it a large quantity of the antiseptic fluid that has gone in due to the hydraulic pressure. The two most popular "empty-cell" processes are called after Lowry and Rueping, the latter having the distinction of being the inventor of the most effective "empty cell" process—which involves the initial injection of air into wood—known to-day.

If the best service is to be obtained from treated timber, not only expert technical advice is necessary as regards the selection of the most suitable wood preservative, but also regarding the most efficient and economical method of treatment. Several specifications for treatment as well as preservatives are known. A selection is imperative. A thorough knowledge of the structure of the timber to be treated is essential. Also, considerable experimentation regarding the treatment characteristics of the timber in question is a necessary prelude for obtaining the best results.

As far as India is concerned, about a hundred of the more important commercial timbers and bamboos have been subjected to investigation during the last twelve years by the Wood Preservation Section of the Forest Research Institute so that the public may write for advice regarding any problem connected with the preservative treatment of Indian timbers and bamboos.

The next factor that requires consideration is the cost of antiseptic treatment. Usually actual cost of pressure treatment which includes interest and depreciation on the investment on the erection of a suitable plant, the cost of handling timber in the yard, etc., works out at about 2 annas to 4 annas per cub. ft. whereas the actual cost of the preservative is very variable. In the case of most preservatives, it varies between 2 annas and 8 annas per cub. ft. With the soaking and brush treatments which are not very effective for outside locations the cost of treatment is naturally very much less.

Timber or bamboos can also be "fire-proofed" which enables the cellulosic material to resist the tendency to burn. The material merely chars so that the charred portion

protects the interior strata from combustion. The three main principles underlying an effective fire-proofing treatment are the impregnation into, or application to, wood of a chemical that would either form a kind of glassy material by fusing on exposure to heat, and thus prevent the access of oxygen to the wood, or will liberate either water vapour or inert gases when the temperature of the wood rises above 150°C. or 200° C. As the water vapour or inert gases dilute the oxygen around the timber, combustion is retarded. The most popular and representative fire-proofing chemicals are sodium silicate, borax and ammonium salts. The practical method of fire-proofing timber is similar to preservative treatment. The cost is also about the same per cub. ft. Some of the more important uses to which chemically preserved timber can be put to with economy not only initially, but in the long run in India are noted below :—

1. *In the railways.*—Sleepers, crossing-planks, roof-trusses, posts, joists, ceiling, planking, doors, windows, partitions, fences, trestle bridges, overhead and foot bridges, culverts, telephone and signal poles, sign-posts, carriage and wagon superstructures, conduit planks, cooling structures, platforms, bulk-heads, water tanks, pile foundations, flooring planks, paving blocks, etc.

2. *In the highways.*—Truss bridges, trestle bridges and bridge approaches, culverts, sign-posts, bulk-heads, retaining walls, guard rails, fence posts, bridge floors (especially of pontoon bridges), etc.

3. *Overhead electrical construction.*—Transmission, distribution, lighting, telegraph and telephone poles, cross-arms, insulator pins, pole struts, guy-blocks.

4. *Building construction.*—Pile foundations, doors and windows, joists, rafters, wall-plates, sub-floors and floors, shingles, roof-trusses, garden structures, summer houses, garages.

5. *Rural construction.*—Posts, poles, bamboos, rafters, joists, flooring, cart-wheels, doors and windows, cattle shed roofs, poultry houses, aqueducts, irrigation channels, garden creeper and vineyard stakes, bamboo supports to sugarcane and other crops.

6. *Factory and mill construction.*—Roof-trusses, building timber of various kinds, wood tanks and chutes, etc.

7. *Marine construction.*—Wharf and pier timbers, fenders, sleepers, roof-trusses, ship and boat building, breakwaters, causeways, overhead bridges, loading docks, etc.

8. *Mine construction.*—Head-frames, shaft houses, gallery lining, tipples, sleepers, coal bunkers, flumes, trestles, tanks, conduits, electrical supports, permanent haulage ways, etc.

The relative economy of treated timber in India may be gauged from the fact that while any species of timber has, weight for weight, about the same strength as iron and steel, it costs, especially in the round, only a fraction as much as metals. Also the cost of working timber is considerably less than that with metals. Since in most cases, even in outside locations, as properly treated timber can be confidently expected to give a life of about 25 to 30 years (a period which synchronises with the "obsolescence" period of most structures), treated timber appears to be not only the most up-to-date structural material but the most efficient and economical building material in India. In these days of engineering and scientific progress, accompanied by a corresponding rapid change of æsthetic ideas and fashions, there is a very strong case for the use of chemically preserved wood in India for structural purposes. Commercial wood preservation has just been born. The Indian Railways and the Mysore Government have treated in their pressure plants several lakhs of railway sleepers and electrical poles. The Government of Madras have been operating, for some time, two small *Ascu* wood preservation plants. The Government of Travancore are putting up shortly a large wood preservation plant. The Government of Bhopal will be shortly using several thousand cub. ft. of *Ascu*-treated timber. The Government of the United Provinces are installing a few thousand electrical distribution *Ascu*-treated poles. The *Ascu* Wood Preserving Agency, the only private wood preservation company, has been operating two large wood preservation plants in Northern India.

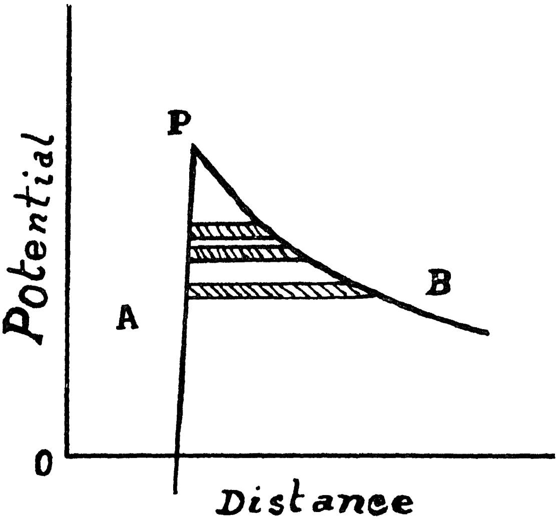
With efficient and extensive organisation, wood preservation will prove to be a great blessing to this tropical country, where fine timber is not only a rapidly growing crop, but cheap and efficient wood-working labour is available throughout the country.

Letters to the Editor.

CONTENTS.

A Note on the Potential Barrier.

IN developing the theory of spontaneous disintegration of α-particles from radioactive substances, Gamow has introduced the idea of a potential barrier in the nucleus. It is assumed that within the nucleus the potential varies as shown by the curve.



Thus at a nuclear distance greater than OP the potential is Coulombian varying inversely as the distance. On the other hand for distances less than OP the potential decreases with the distance.

The α-particles are packed within the region OP. If by some means an α-wave crosses the peak P of the potential wall, it will be set free by the Coulombian repulsive force. To explain this crossing, Gamow has to fall back on Heisenberg's *Principle of Uncertainty*. But it appears to me to be fallacious to apply Heisenberg's principle to this case. The rate of disintegration, however small, has a definite value. It is a phenomenon known with a certainty. It is not, therefore, proper to take help of the uncertainty principle which gives a measure of the "unknowable" to explain what is known definitely with definite experimental values. Moreover, if a theory based on the "certainty principle" is available it would be scientific to give it preference to the one developed on the basis of the "uncertainty principle".

After Gamow's theory Born, Sexl and others deduced a similar formula on assuming the reflectivity and the transmissibility of the barrier. Obviously there can be no objection, as in Gamow's theory, to such an assumption. However, in all these wave-mechanical theories it is assumed that

the energy of the disintegrating α-particles is partly real and partly imaginary. The assumption of particles having imaginary energy is certainly open to criticism. In a recent paper on the subject Sexl[1] has suggested that one has to make the above assumption because the waves within the nucleus are damped.

Before Sexl's paper, just mentioned, was published the writer[2] had developed the wavestatistical theory of disintegration. It was assumed that, on account of a very high value of density, the phase space corresponding to the hard core of the nucleus is viscous. Due to the viscosity, the hydrodynamical waves in the phase space are naturally damped. The theory, it may be noted, has been developed only on the above assumption which is perfectly justified. No assumption regarding imaginary energy is necessary. Further, in so far as a definite nuclear property causing disintegration is assumed, the theory is free from any "uncertainty objection".

In developing the wavestatistical theory the writer has followed Rutherford's model of nucleus. However, it may be mentioned that now-a-days the picture of potential barrier seems to be replaced by Rutherford's model. But it can be easily seen that there is close agreement between the two. It is evident that the sphere of radius OP is Rutherford's hard core, where the whole of the nuclear charge is collected. Beyond OP there is the neutral shell of Rutherford. There are stationary orbits in the neutral shell. And any particle going out of the hard core is caught for a while in one of these resonance levels and *vice versa*. This explains the existence of holes in the barrier as indicated by shades in the figure.

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Presidency College,
Calcutta,
July 15, 1935.

[1] *Zeit. f. Phys.*, 1934, **87**, 105.
[2] *Phil. Mag.*, 1933, **16**, 1097.

Depolarisation of the Light Scattered by Heavy Water.

10 grs. of heavy water supplied as 99·5 per cent pure by the Ohio Chemical Manufacturing Co., is contained in a pyrex glass double bulb which is sealed off after evacuation. The liquid is collected into one of the bulbs from the other by slow distillation. When thus purified, it is found to be quite free from dust. The bulb is painted black all over leaving two small windows for illumination and observation respectively and the depolarisation of the transversely scattered light is measured using sunlight focussed by means of a long focal length lens as incident radiation. The track representing the horizontal component is seen to exhibit a distinct reddish tinge and the depolarisation is obtained as 0·04 after applying a correction for the convergence of rays in the incident beam. This result may be compared with the depolarisation of about 0·06 observed for ordinary water and shows that the heavy water molecule is similar to that of the ordinary water molecule in respect of possessing only a feeble optical anisotropy.

S. BHAGAVANTAM.

Andhra University,
Waltair,
July 12, 1935.

Inhibition in the Benzoin Reaction.

FOR some time this laboratory has been engaged in a study of the kinetics of the benzoin reaction between solid potassium cyanide and benzaldehyde, in the absence of solvents or diluents. It has been shown[1] that two reactions occur, a heterogeneous reaction between solid potassium cyanide and benzaldehyde, and a homogeneous reaction between benzaldehyde and the trace of potassium cyanide which is dissolved by benzaldehyde. This latter reaction is autocatalysed by benzoin and can occur only if benzoin is present.

It has also been shown that the heterogeneous reaction is subject to inhibition in the presence of, for example, potassium iodide or quinol. The inhibition appears to be due to the adsorption of the inhibitor on the surface of the solid potassium cyanide.

This is confirmed by the fact that benzaldehyde contaminated with a trace of an inhibitor can be made to give the normal rate of reaction by allowing it to stand at room temperature in contact with a quantity of solid potassium cyanide too small to produce a measurable amount of benzoin during the time of the purification.

We have now succeeded in showing that with certain substances, inhibition occurs in the presence of small proportions, for example, a fall in the rate of reaction can be detected with benzaldehyde containing one

part in 10^7 of quinone, or one part in 5×10^5 of iodine, or one part in 2×10^4 of sulphur.

Small quantities of water and of certain alcohols accelerate the reaction, but the effect is not so marked as with inhibitors. Acceleration has been detected with, for example, with 1 part of water in 100 of benzaldehyde.

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T. S. WHEELER.

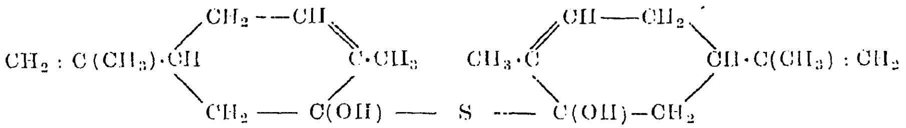
Department of Chemistry,
Royal Institute of Science,
Bombay,
August 2, 1935.

[1] *J. Phys. Chem.*, 1935, **39**, 727, 901, 907.

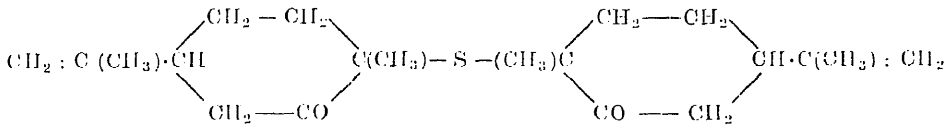
A Note on the Absorption Spectrum of Carvone 'Hydrosulphide' and Its Constitution.

ALTHOUGH the formation of crystalline additive compounds between α-β unsaturated ketones and hydrogen sulphide has been known long since,[1] the constitution of these 'hydrosulphides' is still a matter of some controversy. In the case of carvone 'hydrosulphide' for example, which consists of 1 molecule of hydrogen sulphide and 2 molecules of the ketone, the following structures have been proposed from time to time (I, II, and III).

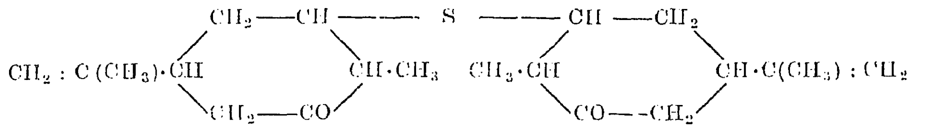
Of these, Formula I due to Harries and Stirm[2] is based on the non-formation of any oxime, semicarbazone or phenylhydrazone by the compound, while Formula II



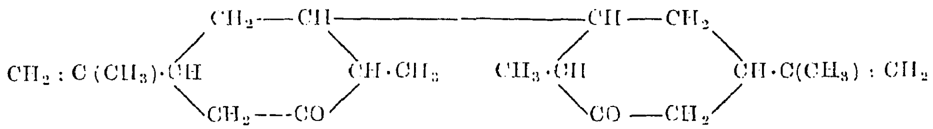
I



II

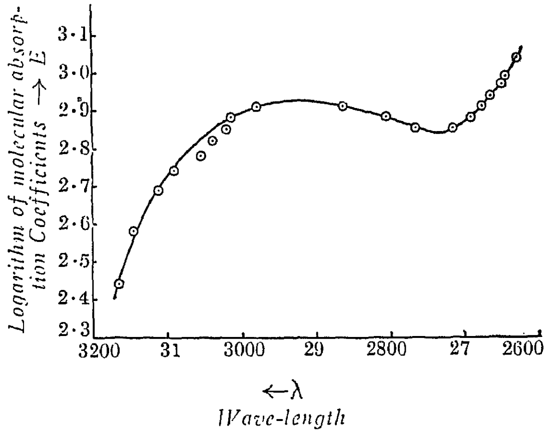


III



IV

put forward by Wallach[3] derives its support from the formation of a dimolecular compound (IV) on addition of hydrogen. The preparation of a dicyanohydrin which readily decomposed to the corresponding dinitrile led Steele[4] to propose (III) for the compound. In order to decide between these alternatives, a quantitative measurement of the ultraviolet absorption of the compound was made with the help of the 'Spekker' spectrophotometer of Hilger. The curve of molecular extinction coefficients given below was obtained with a 1 cm. length of a solution in chloroform of 0·61% concentration. The band at $\lambda = 2900$ Å furnishes direct evidence for the existence of free CO groups in the molecule. The formula of Harries and Stirm is therefore excluded.



Absorption Spectrum of Carvone 'Hydrosulphide'.

The formation of a tetrabromoderivative[5] and the recent work of Hooper, Macbeth and Price[6] on the bis-dinitrophenyl hydrazone of the substance is also in favour of this view. The influence of negative groups like the CO group in making the neighbouring ethenoid carbon atoms more negative is well known[7] and hence the structure proposed by Steele (*loc. cit.*) is put forward as the most probable constitution for carvone 'hydrosulphide'.

R. PADMANABHAN.
Department of Physics,
Indian Institute of Science,
Bangalore,
August 13, 1935.

1 Fluckiger, *Ber.*, 1876, **9**, 468.
2 Harries and Stirm, *Ber.*, 1901, **34**, 1931.
3 Wallach, *Terpene und Campher*, 1909, p. 63.
4 Steele, *Proc. Chem. Soc.*, 1911, **27**, 240.
5 Deussen and Ziem, *J. Prakt. Chem.*, 1914, **90**, 318. Challenger, Smith and Paton, *J.C.S.*, 1923, **123**, 1046.
6 Hooper, Macbeth and Price, *J.C.S.*, 1934, 1147.
7 Lapworth, *Trans. Chem. Soc.*, 1903, **83**, 995.

Is there a Racial Factor in Metabolism ?

RECENT investigations have shown that the basal metabolism of Indians is considerably lower than that of Europeans or Americans and the question has been raised whether a definite racial factor is involved. (*Cf.* Mason[1] who investigated the basal metabolism of South Indian women.) It is interesting to examine, from this point of view, the results of a study made in this Laboratory on the Nitrogen distribution in the urine of South Indians and to see if the metabolic products in the urine show any indication of racial peculiarities. The results quoted in Table I are based on the analysis of the urine of thirty-two normal individuals, including fourteen vegetarians and eighteen non-vegetarians.

The significance of these results from the present point of view is that while the value for Total N. and for Urea-N. (which latter represents the main product of exogenous metabolism) are very low compared to Western standards and indicate a low level

TABLE I.

	Total N.			Urea-N.			Creatinine Coefficient = m.g. Creatinine-N. / Body weight in Kilos		
	Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.
South Indian General ..	7·10	11·11	4·11	4·92	9·06	3·02	9·27	12·8	5·56
South Indian Vegetarian ..	6·20	8·26	4·11	4·30	5·18	3·08	8·48	12·8	5·56
South Indian Non-Vegetarian ..	8·01	11·11	4·17	5·54	9·06	3·02	9·95	12·7	7·30
Europeans	18·0	..	..	16·33	..	..	9·0	..	..

of protein ingestion, the endogenous metabolism which is little affected by the nutritional state of the individual and which might be expected to show a racial peculiarity, is, as measured by the creatinine coefficient, not lower than that of Europeans and Americans. Attention may be drawn in passing to the difference in the averages for the creatinine coefficients of vegetarians and non-vegetarians. So far as this small difference is of any significance, it seems to be in keeping with the work of Abderhalden and Buadze[2] and others who have demonstrated a slightly increased creatinine excretion in dogs after feeding certain amino-acids in massive doses and over a sufficiently long period.

As the creatinine coefficient is generally taken as an index of muscular efficiency, it is satisfactory to find that this factor cannot be correlated with the observed low basal metabolism of South India. The views of the earlier investigators on basal metabolism may be summarised in the words of Lusk[3]: "On the basis of the whole of the evidence it does not appear wise to state that the influence of race or a tropical climate may greatly reduce the basal metabolism." Whether this is not, after all, the correct view and whether under-nutrition, such as is shown to exist in regard to proteins by the present study, is not a sufficient explanation for the low values for Indians obtained by Mason

and others can only be settled by carrying out basal metabolism and dietary studies simultaneously on groups of individuals at different levels of nutrition.

M. DAMODARAN.
K. G. ANANTHANARAYANAN.
University Biochemical Laboratory,
Madras,
July 15, 1935.

[1] Mason and Benedict, *Indian J. Med. Res.*, 1931, **19**, 75.
[2] Abderhalden and Buadze, *Z. Physiol. Chem.*, 1930, **189**, 65.
[3] Lusk, "Science of Nutrition," Saunders, 1928, 168.

On the Absorption Spectra of the Halides of Some Elements of the Second Group: $CdCl_2$; $CdBr_2$; CdI_2; $ZnCl_2$; $ZnBr_2$ and $SrCl_2$.

THE absorption spectra of the above halides of the elements of the second group were studied by the same method of experimental procedure as that adopted by R. Samuel[1] and the regions of the maxima of absorption obtained by plotting the values of log K against wave-length. The salts are very hygroscopic and the preparation of solution offered some difficulty as much heat was developed. In the case of $ZnCl_2$ and $ZnBr_2$ a lower concentration could not be prepared as the addition of water precipitated the salt in a form of colloidal solution which dissolved on the addition of a little HCl and HBr respectively showing hydrolysis. The curve for $ZnCl_2$ indicates that it does not obey Beer's law.

Salts	Maxima of Absorption Wave-length in μ	Log K values
$CdCl_2$	260	−0·76
$CdBr_2$	273	−0·06
CdI_2	No maxima of absorption	
$ZnCl_2$	338—300 (5M) .. 255 (5M strength) 255—227 (M/2 ,,)	−1·48 −0·28 −0·48
$ZnBr_2$	308.. 276	−0·28 −0·08
$SrCl_2$	420 .. 346..312	−1·26 −0·96 −0·69

The above table shows the wave-length of the maxima of absorption of different salts with their log K values.

Details will be published elsewhere.

C. M. BHASKER RAO.
M. KARIM.
Secunderabad,
August 1, 1935.

[1] *Zeit. f. Phys.* 1931, **70**, 43.

A New Device for the Insect Transmission of Spike Disease of Sandal.

IN the course of experiments on the insect transmission of the spike disease of sandal, we experienced a serious shortage of spiked plants having plenty of diseased foliage to serve as the source of infection for the vectors. This difficulty was overcome by conducting the experiments with spiked plants growing under natural conditions in an artificially raised plantation. The plants selected for the purpose offered a branch in a suitably low and oriented position so that the diseased branch could be inserted into the experimental cage, thus providing the source

of infective material. The cage receives also the healthy sandal plant growing in a pot

(Fig.). This method has several advantages over the usual method of providing spiked plants in pots which do not survive the feeding by insects. The diseased branch, on the other hand, being a part of the big plant, is capable of withstanding the attack of the vectors more successfully than the small independent plant with an equivalent amount of branch and foliage. Often, it is advantageous to decapitate the other branches and divert the entire nutriment available, for the vigorous growth of the diseased branch utilised for the experiment. This device has successfully solved the problem of the supply of spiked plants for our transmission experiments and it is hoped that this method may find useful application in the investigation of the other allied diseases.

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Department of Biochemistry,
Indian Institute of Science,
Bangalore,
August 5, 1935.

Oxidative Digestion of Organic Nitrogen.

IT was shown in a previous communication[1] that nitrogen in soils and biological materials can be estimated by a process of oxidative digestion. The present note relates to (*a*) the nature of the products formed under such conditions and (*b*) an improved procedure for their inclusion in the estimate of total nitrogen.

The observations may be summarised as follows :—(1) When an aqueous suspension (or solution) of soil or other biological material is heated slowly with dichromate (or chromic anhydride) and sulphuric acid as in the usual procedure for the wet combustion of carbon, there is invariably some loss of nitrogen, the extent of such loss being inversely related to the rate of heating. The mechanism of this loss is still not clear though there is some evidence to show that ammonium dichromate, which is formed as an intermediate product, may undergo slight decomposition, yielding elemental nitrogen. The loss can be avoided, however, by first heating the material to be digested with water and sulphuric acid and then adding the oxidising agent to the boiling (or nearly boiling) mixture. (2) Small quantities of nitric acid are formed during the digestion. This is supported by the independent observations of Narasimhacharya.[2] The quantities are ordinarily too small to appreciably affect the estimate of total nitrogen even if the digest is boiled without condensing the ensuing vapours. On the other hand, the original material itself may contain useful amounts of nitrate which may be lost if proper precautions are not taken. The use of water or air-cooled condenser, as suggested by Narayanayya and Subrahmanyan (*loc. cit.*) helps to retain all the nitrogen in this form. Subsequent reduction of the digest with zinc or reduced iron in acid medium or Devarda's alloy in alkaline medium helps to include all the nitrate in the estimate of total nitrogen. More recently evidence has been adduced to show that even added nitrates can be retained in the digest and accurately estimated by adopting the above procedure. (3) It has already been shown (Narayanayya and Subrahmanyan, *loc. cit.*) that a part of the nitrogen is always retained in the digest and is not released by mere distillation with alkali. Further evidence has been obtained to show that the major part of this nitrogen is present in combination with the chromium in solution and is released on treating the digest with such reagents as are usually employed for reducing dichromate. The nature of the related compound (or compounds) is still obscure. (4) No information is available regarding the mode of association between nitrogen and the insoluble precipitate formed—especially in the case of soil—during digestion. It may nevertheless be mentioned that any nitrogen which may be present in that form is also included in the estimate of total nitrogen by treatment with reducing agents followed by distillation with alkali.

It was suggested by Narayanayya and Subrahmanyan (*loc. cit.*) that the total nitrogen in the digest can be estimated by boiling with zinc followed by distillation with excess of alkali. Unfortunately, all preparations of zinc (including some of the purest specimens) contain nitrogen. In some cases, the nitrogen content may be as high as that of the material to be digested. Reduced iron also contains nitrogen, though the latter is partly removed by pre-treatment with alkali. Since the major part of the zinc or iron is required for the reduction of unused chromic acid, it was considered desirable to use other reducing agents for that purpose. Among the various re-agents

that were tried, alkali sulphites were found to be the most effective.

Based on the foregoing and other observations, an improved method of oxidative digestion has been developed and will be described elsewhere.

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Department of Biochemistry,
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August, 1935.

[1] Narayanayya and Subrahmanyan, *Curr. Sci.*, 1935, **3**.
[2] Narasimhacharya, *J.S.C.I.*, 1935, **54**, 596 (Abstract).

Injurious After-Effects of Sorghum Growing.

WHILE working at the problem of the injurious after-effects of Sorghum in the black soil tracts of the Tinnevelly District, it was observed that, after Sorghum, the soils became much more compact and much harder than after the Spiked Millet and that their permeability was considerably reduced.

When examined in the laboratory, certain striking differences were observed in the cationic composition of these soils the results of which are given below.

It will be seen that—

(i) the exchangeable soda of the soil is greater when cropped with Sorghum than when cropped with Spiked Millet and

Exchangeable Bases in Millicquivalents per 100 gm. of Air-Dry Soil.

Head of analysis	Soil depths	Cholam*	Cumbu*	Cholam†		
				Before Sowing	At shot blade	After harvest
Soda	6″—12″	4·03	2·26	1·23	2·98	4·28
Potash	6″—12″	1·11	0·91	0·82	0·86	1·11
Magnesia	6″—12″	11·55	13·96	12·55	13·85	13·53
Total bases	6″—12″	55·31	55·23	56·10	55·70	58·10
Soda	12″—1′ 6″	3·55	2·56	1·36	2·66	3·44
Potash	12″—1′ 6″	0·90	0·95	1·07	1·04	0·99
Magnesia	12″—1′ 6″	14·21	15·35	13·62	12·93	13·48
Total bases	12″—1′ 6″	50·92	50·84	48·00	50·30	50·80

* Average of six samples. † Average of three samples.

(ii) the increase is continuous with the growth of the Sorghum crop.

Sorghum or cholam....*Andropogen Sorghum.*
Spiked Millet....*Pennisetum typhoideum.*

It is not known how exactly this increase in Sodium ion is brought about, but it goes a great way to explain the greater deflocculation and the changes in the physical condition of the Sorghum soils, more particularly their reduced permeability.

In addition, a good deal of evidence has accumulated, in the course of our work, which shows that the explanations usually offered for this phenomenon, *viz.*, soil exhaustion, particularly in nitrogen, toxicity due to the decomposition of plant residues are not in themselves adequate. For example, the injury to the succeeding crop is not seen unless the Sorghum crop is allowed to set seed. Addition of nitrogenous manures like Ammonium Sulphate did not remedy the defect nor did the incorporation of Sorghum stubbles brought from outside, give rise to the adverse after-effects.

It looks as though other causes than those abovementioned are responsible for the injury; the increase in Na-ion is probably one such.

V. RAMANATHA AYYAR.
S. KASINATH.
M. R. BALAKRISHNAN.

Agricultural College
and
Research Institute,
Coimbatore,
July 6, 1935.

On a Method of Preparing Large Thin Sections of Plants by Grinding.

IT is a well-known fact that palm-stems show a peripheral crowding of fibro-vascular bundles in their anatomical structure. This

arrangement and the lignification of the sclerenchyma, with the deposition of minerals make the peripheral zone hard and brittle to such an extent in old stems that it is not possible to cut large thin sections by any known means for microscopic examination.

The author while working on the anatomy of palm-stems had to face this difficulty. Various methods for softening such as hydrofluoric acid were resorted to without any success. Ultimately it was thought advisable to harden the entire structure, thus making it possible to grind it to microscopic transparency.

Attempts were made to deposit calcium carbonate and silica inside the cells but it was soon realised that filling the cell cavities with some grindable substance was not enough, as it failed to make the cell walls sufficiently tough to stand the horizontal pull of the grinding. Some substance was required which could be introduced not only into the cell cavities but into the cell wall itself, and later on made to set there with uniform hardness so that it could be ground like a stone. These properties were found in canada balsam, as it is possible to impregnate it uniformly in the whole tissue quickly and without any difficulty with the help of xylol, in which it is miscible in all proportions, and then allow it to set there first by letting the xylol evaporate slowly and then raising the temperature gradually.

For this purpose a transverse slice about 2 mm. thick was cut from a stem with a fine fret-saw. The slice was first boiled in water to drive out all the air and then dehydrated with 50, 70 and 90 per cent. alcohols first quickly and then more slowly, towards 100 per cent. The time varies with the size of the vessels and that of the lacunæ in the ground tissue of the type selected. The whole process up to 90 per cent. takes about 30 minutes. There is practically no harm done by the sudden changes of the grades of alcohol, as the peripheral tissue in palms is always hard enough to sustain the shocks and even the ground-tissue in that zone gets thickened with age. After 90 per cent. alcohol the case is otherwise. The material should be kept in absolute alcohol as long as possible with frequent changes for the purer absolute alcohol. In practice 24 hours are enough. When the dehydration was complete the alcohol was gradually replaced by xylol, and the material was left for another 24 hours in pure xylol. To this, later on, canada balsam was grad added and the xylol allowed to evap slowly in a bath till a syrupy solution re ed. The material in the syrupy sol was kept in the drying bath at a temper of about 50°–60° C. to evaporate the for 24 hours or less (depending on the t ness of the slice and other factors). O next day the material was fixed on a slab with pure hot canada balsam just a fossil slide. The fixed material was ground with fine carborundum powde a plane surface, and then it was unfixe softening the balsam by heat and fixed with a ground surface towards glass. Then the other surface was gr down till the section became suffici transparent for microscopic examina When the required thickness was obt the carborundum powder was rem from the section by washing with xylo brushing with an ordinary painting b The section was then ready for mounti a permanent preparation.

Generally it is not necessary to stai sections as the tissue is found al differentiated in colour but if staini required then the balsam should be rem completely by constant washing with and then bringing the material into wat passing it gradually through the diff grades of alcohol in reverse order.

The author was able by this metho prepare sections for his investigatio comparatively short time and without culty. The time usually lost in sharpe razors was utilised in grinding the ma and even such hard and thoroughly lig and mineralised structures as the old s of *Bactris major*, *Areca catechu* and *Orec oleracea* gave excellent results. The sec obtained were thin enough to be pl graphed under a magnification of 50 meters. Sections prepared by this me are in fact indistinguishable from t prepared by cutting. It is also possibl this method to obtain sections of ti which are brittle or too fragile to be wo with a microtome. The author has succe in getting good sections from a well-d loped *Areca catechu* stem, in which case the central ground-tissue was found t mineralised. In the accompanying illu tion the ground-tissue is shown h magnified. The perfection of the me will be realised from the fact that the lac structure of the ground-tissue is seen i

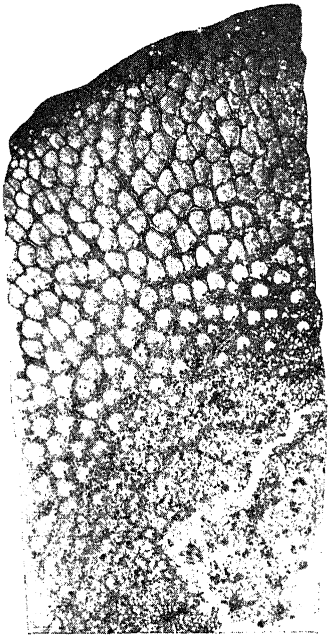

Fig. 1.
Areca catechu. Transverse section showing highly lignified sclerenchyma of the fibro-vascular bundles in the dermal, sub-dermal and the central zones. × ca 2.

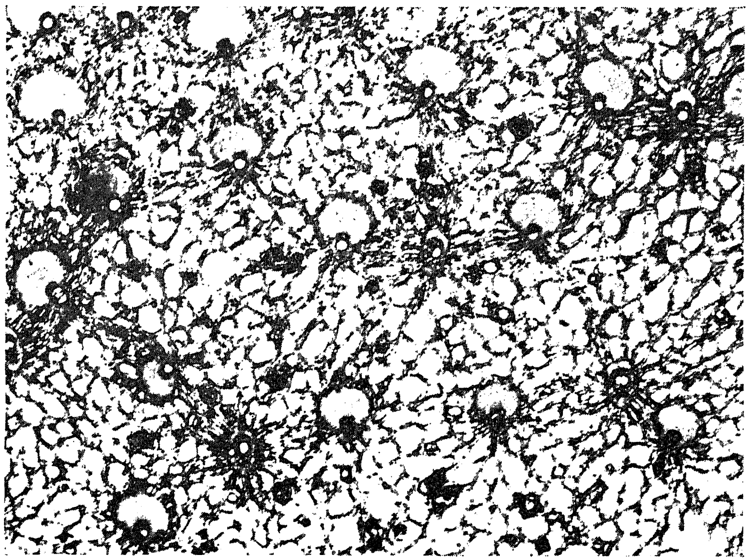

Fig. 3.
The same section. Sub-dermal zone showing the lacunar ground-tissue intact. ×10.

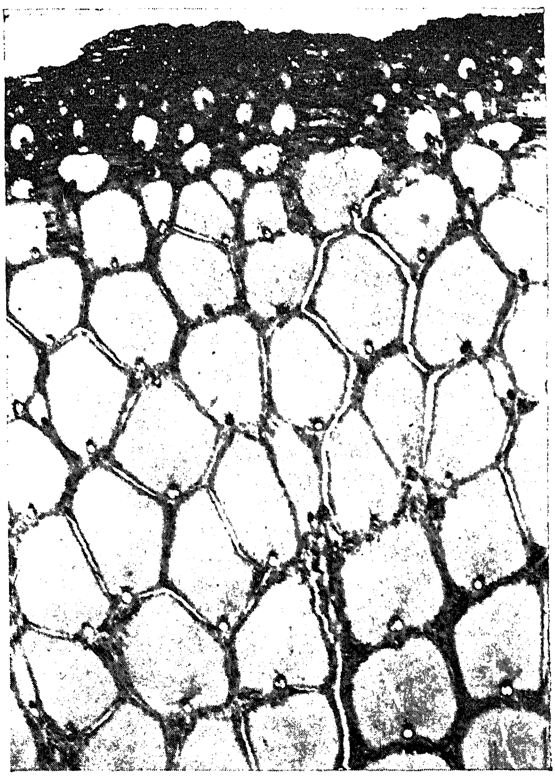

Fig. 2.
The same section. Dermal zone only, showing highly lignified sclerenchyma of the fibro-vascular bundles. × 10.

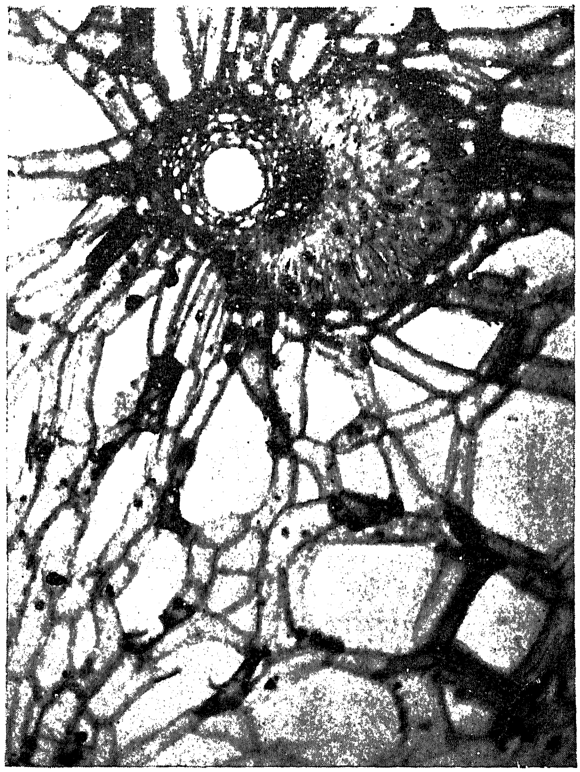

Fig. 4.
The same section. Central zone, highly magnified to show the cell walls of the comparatively soft

and from the perfect, unbroken walls of the individual cells.

K. N. KAUL.

Department of Botany,
University of Lucknow,
July, 1935.

"Dionyle P. W." for Rapid Penetration of Fixatives.

IT is well known that plant material containing air, for example, flower buds and leaves, etc., does not easily sink to the bottom of the tube containing liquid fixatives specially in those which do not contain alcohol and thus the process of fixation is not as rapid as it should be. When there is plenty of air within the tissues the material remains floating on the surface for a long time or it does not sink at all. Usually suction pumps or water aspirators are used to get rid of the air but in many cases even these are not of much help.

A French Engineer Chemist, Mr. Auguste Blondon of the firm S.A.P.I.C., 33, Quai de Seine, L' Ile-st-Denis, Paris, has recently manufactured a chemical product in the powder form known as Dionyle P. W. which, if added to any plant fixative, allows the material to settle to the bottom with great ease. I have seen Dr. A. Eichhorn using this chemical very successfully with roots, flower buds, etc. I myself have used it with success for fixing the ærial mycelium of Pythium. Dr. G. Archambault[1] has tried this chemical and is of opinion that it is very good for rapid penetration of fixatives. He compared the sections of plant material fixed with and without Dionyle in the fixatives and found that the addition of the chemical did not produce any undesirable effects. It has some physical action on account of which pieces of roots sink down rapidly in the fixatives, but in case of leaves and flower buds water aspirators may have to be used for about 2 to 5 minutes. Dionyle is an ether salt of β-naphthalene sulphonic acid with butylic alcohol and isopropylic alcohol. It is easily soluble in water and is neutral in reaction. During the process of its manufacture a little sulphuric acid appears which is neutralised by sodium sulphate, which is not bad for fixation.

In fact it is used in Zenker-formaol[2] fixative the composition of which is given below:

Bichloride of Mercury	.. 5·0 gm.
Bichromate of Potassium	.. 2·5 gm.
Sulphate of Sodium	.. 1 gm.
Distilled Water	.. 100 c.c.

To 9 c.c. of this add 1 c.c. of neutral formaline at the time of using the fixative.

Dr. Eichhorn adds Dionyle to any fixative whatever its composition may be.

In France this chemical is used as steeping agent in Dyeing Industry of wool and cotton in the proportion of 0·1 gm. per 100 c.c. of water. Dr. Eichhorn and Dr. Archambault use the same proportion for plant material. It is added to the fixative before the material is put for fixation or even afterwards. It is not necessary always to weigh it.

The Dionyle P. W. is very cheap and can be had from N. Boube 'e and Cie, 3 place St.-Andre-des-arts, Paris (VI). The price for 50 gms. is 4·50 francs and for 100 gms. is 8 francs, *i.e.*, Re. 0–14–0 and 1–10–0 respectively according to the present rate of exchange. It is better to keep it in glass-stoppered bottles.

R. K. SAKSENA.

Department of Botany,
University of Allahabad,
August 12, 1935.
At Present :—
C/o Prof. A. Guilliermond,
Memb. de l' Inst.,
12 Rue Cuvier, Paris, Ve.

[1] Archambault, G., *Revue de cytologie et cytophysiologie Vegetales*, 1935, **1**, 173-174. (Published by Prof. Guilliermond, Paris.)

[2] Laugeron, M., *Precis de Microscopie, Masson, Paris*, 1934, pp. 342.

A Rare Instance of Change of Tropism in *Arachis Hypogæa*, Willd.

THE ovary of the groundnut flower, after fertilisation, develops a stalk or gynophore at its base. It elongates rapidly carrying the ovary at the apex which piercing the soil buries the ovary, where it develops into a pod. The structure of the gynophore is almost the same as that of the stem. But, peculiarly enough, while the stem is negatively geotropic, the gynophore is always positively geotropic. This tendency is shown very early even when the gynophore is just a few millimetres long. In 1932, the authors came across a unique specimen of a groundnut plant of A.H. 32—a Spanish Bunch variety, grown under dry conditions (Fig. 1) in which the "pegs" or gynophores exhibited different degrees of geotropism :—14 pods

developed normally and produced seeds; 7 gynophores were quite erect showing

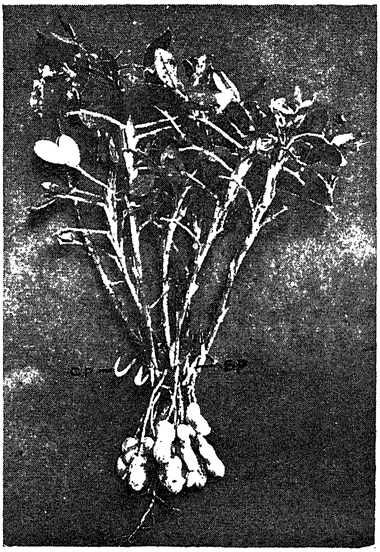

Fig. 1.

Groundnut plant with negatively geotropic gynophores. E.P.—Erect peg. C.P.—Curved peg. × 1/4 Nat.

complete, negative geotropism; 4 gynophores after a period of normal downward growth began curving upwards, exhibiting change of tropism.

There was development of chlorophyll at the dilated and pointed apices, *i.e.*, the ovule-bearing portion of some of the abnormal pegs. One of these was quite green like a stem. The abnormal pegs did not produce normal pods and seeds.

With regard to the other morphological characters there was nothing unusual. The few normal seeds obtained from the abnormal plant were sown; but the offspring was quite normal and no peg showed either partial or complete negative geotropism. The chances for the occurrence of the abnormality seem to be very rare being less than one in a million, and no specimen other than the one mentioned could be found during the last three years.

With a view to explain the abnormality, a histological study was attempted. The epidermal cells at the tip of the normal gynophores (Fig. 2) are found to contain many round bodies—plastids. There are as many as 5–20 bodies in each of the cells at the tip. The number of the bodies gradually decreases away from the tip. They are round and 1 μ to 4 μ across. In specimens fixed in formalin-acetic alcohol, and stained with Haidenhain's hæmatoxylin, the plastids are

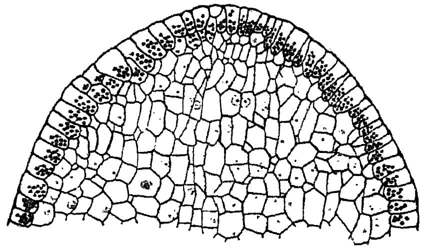

Fig. 2.

Longitudinal section of positive geotropic gynophore with numerous dark bodies in the epidermal cells. ×120.

seen as dark bodies almost filling the upper part of the cell cavity (in sections 10 μ thick) (Fig. 2). But in the abnormal pegs, the plastids are comparatively few or wanting (Fig. 3). When present they appear shrunken and much smaller than the normal.

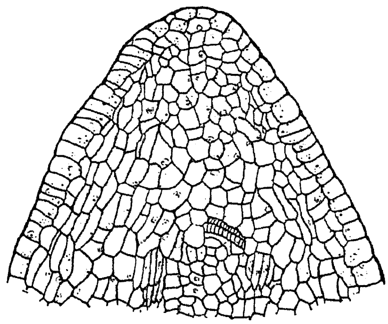

Fig. 3.

Longitudinal section of negatively geotropic gynophore with a few disintegrating bodies in the epidermal cells. ×120.

Waldron, R. A. (1919) while recognising the effect of gravity in bringing about the downward growth of the gynophore, considers that "the presence of definite granules in the lumen of each of the epidermal cells of the gynophore at the tip and their absence anywhere else suggest the possibility of such being the structures by which the organ perceives when it is out of line with gravity". He had, however, no opportunity to study the behaviour of negatively geotropic gynophores.

The effect of gravity alone is not the immediate, decisive factor in bringing about the downward growth or positive geotropic movement of the normal peg. Because in spite of gravity some of the pegs changed the direction of growth, there must be a cause more directly responsible. From the

abundance of the plastids in the normal pegs and their scantiness in the abnormal ones, it may be inferred that these bodies or the organs of perception that respond to gravity and bring about positive geotropic movement. The plastids appear first after fertilisation. If they are not formed at that time, the peg grows quite erect. In some pegs, the number and the size of the plastids get diminished, or they might disintegrate, after a period of normal growth; and then the peg curves upwards and becomes negatively geotropic. The function of the plastids is not analogous to that of the freely moving starch grains in certain grass roots, where they are said to bring about curvatures due to internal excitement set up by them (Statolith theory of geotropism). Unlike the starch grains, the plastids are confined to the upper part of the lumen of the cell. Their exact nature and the reason why after a period of normal functioning, they become affected and functionless, in certain rare instances, are not known; further study is expected to throw light on this very interesting subject.

The abnormal pegs did not produce any pods and seeds possibly for want of medium of sufficient resistance. In a set of experiments conducted in the Oil Seeds Section, the developing gynophores were made to enter artificially made up media. For this bamboo tubes about six inches long and about an inch in diameter and having a node septum at one end to act as bottom, were filled each with wet and dry, ordinary soil, stiff clay, sterilised sand, powdered wood charcoal, saw dust, cotton wool and also water separately. Empty tubes, dry and moist, were also set up. The tubes were buried in the soil to keep them in position and were covered with circular paraffined straw boards to make the tubes dark inside. Small perforations just to allow the passage of the gynophore were provided. Pods developed uniformly in the soil, clay and powdered charcoal irrespective of the medium being moist or dry; but pods did not form in the other media, *viz.*, saw dust, cotton wool and air, possibly for want of sufficient resistance.

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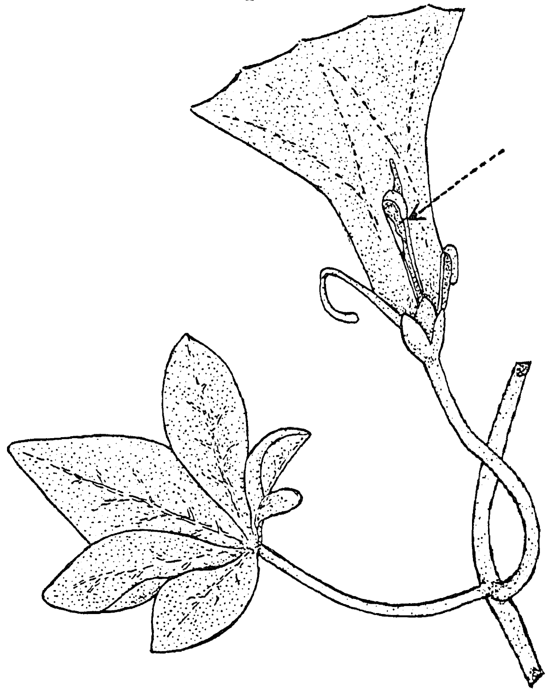
June 7, 1935.

Duplicate Corolla in *Ipomœa palmata* Forsk.

Ipomœa palmata Forsk is a common garden convolvulus in Bombay. Ordinarily its flowers have a single infundibuliform corolla.

Recently, a plant of this species has been observed putting forth flowers which bear five additional free petaloid structures about



3 cm. long and 0·5 cm. broad, arising outside and jointly with the base of the corolla. The facing of this new whorl is inside out.

This additional development in a large number of flowers on a single plant is worth registering.

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Wilson College,
Bombay 7,
July 22, 1935.

Studies in the Development of the Pollen Grain and Embryo Sac of *Wolffia arrhiza*.

THIS interesting plant—the smallest angiosperm known—is seldom seen flowering. In November, 1933, the writer found it flowering abundantly near Agra. A study of the development of the gametophytes revealed several important differences from those of *Lemna minor* (Caldwell, 1899).[1]

Microsporogenesis and Male gametophyte.—The stamen, in early stages, consists of a very short filament and a spherical anther containing a mass of homogeneous cells

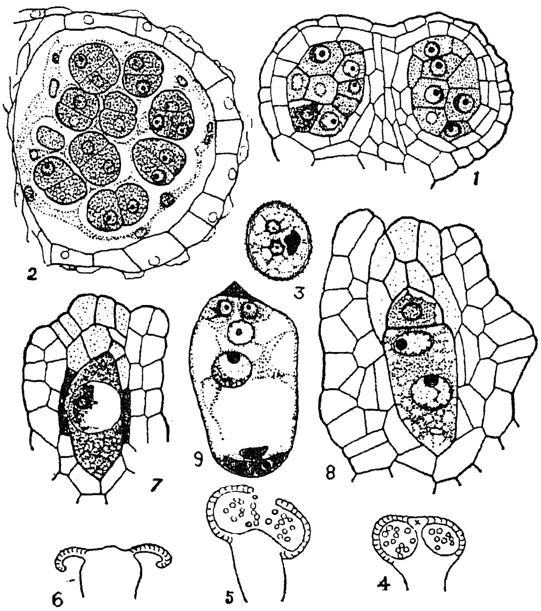
covered over by the epidermis. Soon a sterile plate of cells running vertically divides this mass into two so that by the time the peripheral archesporial cells cut off the primary parietal layer, the microspore mother-cells are seen in two distinct groups and the anther becomes bilobed in outline (Fig. 1). The primary parietal layer divides to form the endothecium and the tapetum (Fig. 1); there is no middle layer whatever. At maturity the cells of the endothecium enlarge and develop the usual fibrous thickenings while the epidermal cells degenerate and are sloughed off.

The tapetal cells, which remain only one-nucleate, become amœboid and project into the loculus (Fig. 2). The reduction divisions in the microspore mother-cells are successive, but a few cells lying towards the periphery do not undergo any divisions and degenerate.

In the pollen grain the generative nucleus is at first organised into a small lenticular cell separated from the large tube cell by a narrow space. Later, the generative nucleus becomes free though still surrounded by a cytoplasmic sheath. At this stage the periplasmodium is about to disappear completely and so is the sterile partition between the two lobes. The mature pollen grain is three-nucleate and the tube nucleus shows a degenerated appearance (Fig. 3).

The dehiscence of the anther is rather interesting. About the time when the pollen grains are 2-nucleate, the cells of the endothecium lying just over the sterile partition (at *x* in Fig. 4) presents a degenerated appearance and do not show the usual fibrous thickenings—these cells facilitate the opening of the anther (Fig. 5). At this stage the sterile plate of cells separating the two loculi also disappears and the two halves of the endothecial coverings curve outwards and downwards exposing the entire mass of pollen grains for dissemination (Fig. 6).

Megasporogenesis and Female gametophyte.—The nucellus in the early stages consists of only a few cells—the hypodermal archesporial cell usually surrounded by one layer of cells. This cell cuts off the primary parietal cell which undergoes one or two anticlinal divisions (Fig. 7). The megaspore mother-cell enlarges considerably destroying the whole of the nucellus except the two layers of cells at the top, so that the lateral sides of the subsequently formed embryo sac lie immediately adjacent to the inner integument. The megaspore mother-cell divides into two cells of which the upper degenerates while the lower, after 3 successive divisions of its nucleus, forms the normal eight-nucleate embryo sac (Figs. 8–9). Thus the development of the female gametophyte is of the "*Scilla type*" while in *Lemna*, Caldwell



FIGS. 1-9.

Figs. 1-9, showing the development of male and female gametophytes in *Wolffia arrhiza* Wimm Figs. 1-2 ×375. Figs. 4-6 ×43. Figs. 3, 7, 8, 9 ×630.

(1899) reported this to be of the "*Lilium type*". The antipodals are ephemeral and the polars fuse early (Fig. 9).

The ovule remains orthotropous throughout its development. Of the two integuments, the outer begins to develop only after the megaspore mother-cell has undergone one division. The carpel shows a clear stylar canal extending throughout its length. Further investigation on the development of the endosperm and embryo is in progress.

I am greatly indebted to Dr. P. Maheshwari for his kind help and valuable suggestions.

B. L. GUPTA.

Department of Botany,
Agra College,
Agra, India,
March 29, 1935.

[1] Caldwell, O. W., "On the life-history of *Lemna minor*," *Bot. Gaz.*, 1899, **27**, 37-66.

A Note on the Chromosome Numbers of Some Eleusine Species.

N. S. RAU[1] (1929) considered 36 as the probable diploid number in the root-tips of *E. coracana* Gaertn. Avdulov[2] (1931) has determined 18 and 36 to be the diploid numbers in Eleusine and suggests 9 or 10 to be the basic number of the tribe *chlorideæ*. Hunter[3] (1934) confirms the number 36 for *E. coracana* obtained by Avdulov.

The present investigation was taken up to determine the chromosome numbers in some of the local Eleusines. The following species, collected at Coimbatore, were studied :—*E. coracana*, Gaertn.; *E. indica*, Gaertn.; *E. brevifolia*, Br.; *E. ægyptiaca*, Desf. Flower buds were killed between 10-11 A.M. in the following fixatives: Carnoy's, Allan's modification of Bouin's and Flemming's (weak). Sections were cut at 10-12 μ and stained in hæmatoxylin and also gentian violet iodine.

The haploid chromosome numbers were determined in metaphase plates and at diakinesis as follows :—*E. indica*—9 ; *E. coracana*—18 ; *E. brevifolia*—18 ; and *E. ægyptiaca*—17. Secondary pairing was noticed in the last three species. It is evident that *E. indica* is a diploid, *E. coracana* and *brevifolia* are tetraploids, while *E. ægyptiaca* is probably a tetraploid with one pair lost ($4x-2$). The basic number is, obviously, 9.

N. KRISHNASWAMI.
G. N. RANGASWAMI AYYANGAR.
Millets Breeding Station,
Coimbatore,
June 14, 1935.

[1] Rau, N. S., *Indian Jour. Bot.*, 1929, **8**, 126.
[2] Avdulov, N. P., *Bull. Appl. Bot. Genet. & Plt. Breeding*, 1931, **43**, 428 ; *Eng. Trasl. Summary Imp. Bur. Plt. Genet. School of Agric.*, 633, 1 ; **576**, 312 ; **576**, 16.
[3] Hunter, A. W. S., *Canadian Jour. Research*, 1934, **11**, 213.

Two New Host-Plants of *Loranthus* at Allahabad.

THE partial parasite *Loranthus* commonly grows in the Upper Gangetic plain on a number of host-plants belonging to different families of the Dicotyledoneæ. They are especially found on trees or shrubs, the commonest hosts being *Mangifera indica* and *Bassia latifolia* (Duthie,[1] Brandis[2]).

In January 1935, the author observed this parasite growing on a guava (*Psidium Guayava*) tree, which was an unfamiliar sight. No other plant in the vicinity, but a number of guava trees in an orchard about 2 miles off, had *Loranthus* on them. On looking up the literature on the subject,

Fig. 1. *Loranthus longiflorus* on *Psidium Guayava*.

Fig. 2. *Loranthus* sp. on *Citrus medica* var. *acida*.

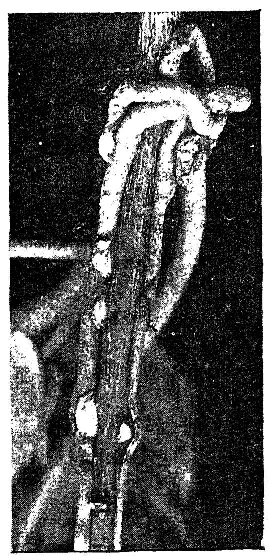


Fig. 3. The same as Fig. 2. showing the secondary roots and haustoria of the parasite.

no mention of *Psidium Guayava* as a host of *Loranthus longiflorus* was found.

A knob was, as usual, formed at the junction of the parasite and the host (Fig. 1). The parasite produced a number of branches with glabrous and somewhat leathery leaves. Flowers and fruits were present. The parasite was *Loranthus longiflorus* Desr. which is the commonest species in the United Provinces.

Psidium Guayava is a non-indigenous plant of the family Myrtaceæ with bark composed of dry membranous layers but now it is naturalised throughout India (Hooker[3]).

Scott[4] and Bidie[5] are of opinion that plants having deciduous bark with dry membranous layers are unfavourable hosts of this parasite.

Fischer[6] dissents from the above view and has mentioned in his list, a number of plants attacked regularly by the parasite, which have similar characters of the bark, but very few plants of the family Myrtaceæ, especially the non-indigenous genera, are recorded by him as host-plants.

Patwardhan[7] noted *Eucalyptus rostra*, a non-indigenous plant as a host of *Loranthus longiflorus* in Poona. Kamerling[8] mentions *Loranthus dichrous*, a species not found in India, on *Psidium Guayava* in Brazil.

Later on, sometime in the middle of February, the parasite was seen growing on another new host-plant, *viz.*, *Citrus medica* var. *acida* (Fig. 2). The primary root was not seen at that stage. A number of secondary roots were seen arising at the point of infection which was the junction of the host and parasite. A knob-like structure was formed at this point. These roots grew outwards and spread over the surface of the host-plant, coiling round in every direction and sending out the haustoria into the tissues of the host to absorb the necessary nourishment (Fig. 3). The roots vary in size and length with age. Some of these were fairly thick and brown with a number of lenticles on them, others were thin and green in colour, with conical growing tips. From these spreading roots, erect branches bearing a number of foliage leaves were developed. By means of these secondary roots the infection is spread over the surface of the host-plant. These roots were not sensitive to gravity as they seemed to be going up or down the branch indiscriminately. The bark of the host-plant was fairly thick.

Fischer[6] in his list mentions *Citrus medica* as a host for *Loranthus neelgherrensis* and another species (not named) of *Citrus* attacked by *Loranthus elasticus* in Southern India. Both of these species of the parasite are not found in Northern India.

I am to express my great indebtedness and sincere thanks to Prof. J. H. Mitter for his kind suggestion and advice. Thanks are also due to Mr. Anil Mitra, for preparing photographs.

G. D. SRIVASTAVA.

Department of Botany,
University of Allahabad,
August 12, 1935.

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A Note on a Comparative Study of the Chromosomes in Ten Species of Indian Dragonflies.

LEFEVRE AND MCGILL[1] as co-workers (1908), Smith[2] (1916) and Oguma[3] (1930) are the only authors who so far have devoted their attention to the chromosome studies in this very ancient family of insects. In a paper published by Oguma and Asana[4] (1932) attention was drawn to a very interesting observation, whose significance is not yet quite clear, that the so-called *m*-chromosome (the smallest among the autosomes) presents every grade of size reduction among the testicular cells of a single individual belonging to a species of *Odonata*, *Tramea chinensis*, collected in the vicinity of the Gujarat College, Ahmedabad, Western India.

This rather remarkable observation led us to make a comparative study of the chromosomes in the male germ cells of some ten species of Indian dragonflies so far collected, from a very restricted area situated in the neighbourhood of the Ismail College, Jogeshwari, about 20 miles north of Bombay. The following observations are based on the species listed below.

May we take this opportunity to express our thanks to Colonel F. C. Frazer who very

kindly identified the species for us. A short account of our observations on the chromosome numbers, the X-chromosome and the *m*-chromosome of these Indian species of dragonflies is given below:

Species	Haploid	Diploid
Sub-Order Anisoptera		
Sub-family Libelluniæ		
1. *Pantala flavescens* ..	13	25
2. *Tramea limbata*	13	25
3. *Trithemis palladinervis* ..	13	25
4. *Diplacodes trivialis* ..	13	25
5. *Brachythemis contaminata* ..	13	25
6. *Crocothemis servilia* ..	13	25
7. *Potamarcha obscura* ..	13	25
8. *Orthetrum sabina*	13	25
Aeschininæ		
9. *Ictinus rapax*	12	23
Sub-Order Zygoptera		
Family Coenagrionidæ		
10. *Ceriagrion rubiæ*	14	27

As will be seen from the above table, all the members of Libelluniæ show a constancy in the number of chromosomes, 25 in diploid and 13 in haploid. In *Ictinus* which belongs to another group, Aeschininæ, the diploid is 23, the haploid 12. The chromosome number in *Ceriagrion* (Coenagrionidæ), whose chromosomes have been studied for the first time, the number is the largest among all the dragonflies studied so far.

Despite the variation in the chromosome number, there is present an unpaired X-chromosome, without exception, in all the species investigated. In every case, the X-chromosome always takes a peripheral position on the outer circle of the spindle both in the spermatogonial and primary spermatocyte metaphases and acquires a peculiar eccentric position in the metaphase of the secondary spermatocyte. And a special emphasis may be laid on the fact that it separates into two equal halves in the primary spermatocyte division, but migrates to one pole entire without separation, ahead of other chromosomes, in the second spermatocyte division.

However, regarding its size or magnitude in relation to other chromosomes it does not show a uniform behaviour in all the ten species studied. Taking first all the species of Libelluniæ, the X-chromosome in all of them looks nearly, though not exactly, equal in magnitude to the second smallest autosome univalent in the spermatogonial complex. While in *Ictinus rapax* (Aeschininæ), it is interesting to note, the X-chromosome stands as the largest element in its chromosomal complex. It is remarkably large and occupies a central position in the spermatogonial metaphase. In *Ceriagrion rubiæ*, a representative of our third group, Coenagrionidæ, the X-element, in its size relation to other members of the complex, resembles the X-chromosome in the species of Libelluniæ.

Finally, throughout all these Indian species of dragonflies the smallest autosome, the so-called *m*-chromosome, is present without exception. And it is a remarkable fact that the relative magnitude of this *m*-chromosome to that of the X-element varies from species to species.

A full account of these observations will be published elsewhere.

J. J. ASANA.
S. MAKINO.

Gujarat College,
Ahmedabad, India.
and
Hokaido Imperial University,
Japan.
July 26, 1935.

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[3] Oguma, K., "A comparative study of the spermatocyte chromosomes in allied species of the dragonfly," *Jour. Fac. Sci. Hok. Univ.*, Ser. VI, 1930, **1**.

[4] Oguma, K., and Asana, J. J., "Additional data to our knowledge on the dragonfly chromosomes, with a note on occurrence of X- and Y-chromosomes in the ant-lion (Neuroptera)," *Jour. Fac. Sci. Hok. Imp. Univ.*, Series VI, 1932, **1**.

Madras Fisheries Department.

Two serious misapprehensions on the part of the reviewer of my report on the Madras Fisheries Department for 1933–34 in the June number of the *Current Science* call for remarks :—

Hilsa.—The reviewer states, "The Department's efforts to introduce *Hilsa* along the west coast are not likely to meet with success as there are no large rivers in that area for fish to run up for spawning purposes." There is nothing in the report to lead the reviewer to believe that the Department is making such efforts. More than 25 years ago the late Mr. Wilson made a solitary experiment of planting some *Hilsa* eggs in the Ponnani river. This was never repeated as the unsuitable nature of the west coast

rivers for the breeding of *Hilsa* was recognised years ago by the Department.

Catla.—Regarding the introduction of *Catla* in the Cauvery the reviewer has misunderstood the scope and aim of the Department's operations. He remarks as follows: "It is doubtful, however, whether any good can result from the stocking of the upper waters of the Cauvery because the fish is not adapted to live in clear rapid running water." The "upper reaches" referred to is the section of the Cauvery river above the Mettur Dam up to the Hoginkal falls (now the Mettur reservoir) and the reach immediately below the Dam. The reviewer is wrong in assuming that *Catla*—which is "a tank fish" in the sense that it enters tanks for feeding and growth—does not live in rivers. Our studies of the habits of *Catla* as well as experience in its culture in South India for the last 20 years prove beyond doubt that *Catla* will not breed in the stagnant water of tanks and ponds like some other carp though they grow and thrive in them, but require a river or stream of running water for breeding. The experience of culturists elsewhere in India has been the same. A striking evidence of this—if proof is needed—is found in the occurrence of *Catla* in the Cuddapah and Nellore Districts, only where the tanks and rivers (the Pennar river system) are directly connected by the Cuddapah-Kurnool canal with the upper waters of the Kistna (Tungabhadra) in this Presidency. Soon after this canal was opened, *Catla* began to appear in the Pennar river and connected tanks in the Cuddapah and Nellore Districts where it was unknown before.

The reviewer may rest assured that the Madras Fisheries Department does pay some regard to the ecology of fish that are subjected to artificial cultivation.

B. SUNDARA RAJ.

Madras Fisheries Bureau,
July 11, 1935.

IN the above note attention is drawn to two supposed "serious misrepresentations" on my part. In my review I represented the Madras Fisheries Department as making efforts to introduce *Hilsa* along the west coast and of stocking the clear rapid-running waters of the Cauvery with *Catla*. At the very outset, it may be stated that I had no intention of running down the work of the Madras Fisheries Department or of minimising the splendid efforts that are being made in that province in connection with the improvement of fisheries.

The title of my review—"Madras Fisheries Department"—is partly suggestive of the scope of my remarks. For the purpose of an adequate review of the last report of the Department, I read several earlier reports and the impressions I gained from this study are embodied in my comments on the work of the Department. In order to follow my remarks about *Hilsa* and *Catla*, the readers are, therefore, advised to study the relevant parts of the earlier reports of the Department as well.

It is a great relief to learn now for the first time that the experiments started by the Department about the introduction of *Hilsa* along the west coast are not being repeated. Regarding *Catla*, however, the position is somewhat different. In the report for 1930–31 (para. 144, p. 44) it is stated that "*Catla* has been stocked in upper waters of the Cauvery first below the Hoginkal falls and later at Mettur above the dam." My submission is that pools below waterfalls are not suitable for stocking fishes of the *Catla* type, which is essentially a fish of sluggish waters, such as ponds, tanks, large rivers, etc. Moreover, the description of the stream below the falls shows that it consists of rapids, and, if this is really so, the fish has no chance to live and flourish as *Catla* is not adapted for life in swift currents. My assumption is borne out by the results obtained by the Madras Fisheries Department which has been stocking with *Catla* the Cauvery below the falls for a period of several years but has not obtained any definite proof so far that the fish has established itself in these waters. With the formation of the "Mettur reservoir" the results may be different.

What is stated in the above note regarding the ecology and bionomics of *Catla* is elementary knowledge for people of northern India. *Catla* breeds during monsoon floods when it gets an opportunity to leave its permanent abode and enters shallow, warm waters of paddy fields, etc. So far as my information goes, it does not breed in rivers but in the flooded country adjoining them.

REVIEWER OF THE REPORT.

Dairy Science.*

MILK is the most important food of man and beast and in the early stages of their life, offers the only source of nutriment ensuring steady maintenance and growth, building up immunity against disease and laying the foundations of the future health of the individual. The constituents of milk, proteins, sugars, fats, pigments and minerals are so well-proportioned as to render this product one of the most easily digestible and highly assimilable of all foods. These unique properties and its indispensability in the nutrition of animals, have been responsible for stimulating a vast amount of research on the physical, colloidal, chemical, bacteriological and nutritional aspects of milk.

The recent publication entitled *Fundamentals of Dairy Science*, is devoted to a discussion of these fundamental questions and provides detailed and authoritative information on these various aspects from a purely scientific point of view.

The first five chapters deal with the chemical composition of milk and milk products, and proteins, fat and carbohydrates comprising the essential constituents of milk. An entire chapter has been devoted to an able review on the pigments of milk which have assumed great importance in relation to vitamins and respiratory enzymes.

Milk furnishes one of the finest examples of a typical and perhaps a comprehensive colloid, several phases of varying degrees of dispersion, participating in the system. A beautiful discussion of this colloidal aspect is to be found in the chapter on the physical equilibria of milk. The sizes of particles which were wrongly expressed in the previous edition have now been corrected and the conventional and generally accepted unit, $m\mu$, adopted.

Many of the physical and chemical properties of milk, which are of great importance from an industrial point of view, have been discussed in relation to certain processes in the dairy industry. The creaming ability of milk has been correlated with the state of aggregation of the fat globules and the effect of several industrial treatments like pasteurisation, homogenisation, etc., on creaming has been discussed from the fundamental standpoint. In a similar manner, the quality of foaming, cream-whipping and coagulation in relation to cheese manufacture, which is one of the most important of dairy industries, have been treated.

Milk is an excellent culture medium for the growth of various types of micro-organisms including many bacteria pathogenic to man, and the large-scale production, handling and transportation of such a product, therefore, present problems in pasteurisation, maintenance of sterility etc., involving a rigorous bacteriological control, which is facilitated by a close understanding of the ecology of the bacterial associates, their multiplication and growth in relation to the physical and chemical properties of milk. These problems are presented in the series of chapters devoted to a discussion of the microbiology of milk and milk products.

The last two chapters provide information of great interest not only to the physiological chemist but also to the general reader. The nutritional value of milk in the early and later stages of the life of an animal, is discussed in relation to other sources of nutriment. Attention is drawn to the incidence of nutritional anæmia due to the low content of iron and copper in milk, constituents found essential for the regeneration of hæmoglobin. Vitamin constituents of milk in relation to breeds and feeds are discussed.

The rôle of colostrum in the nutrition and immunisation of infants and young ones has been the subject of controversy and a useful discussion of this vital subject which is presented in the volume is helpful to those investigators interested in this aspect of milk nutrition.

Most of the valuable information contained in the volume relates naturally to cow's milk which is the most important dairy animal in the world; but there are other animals like the buffalo and the goat which are the main, if not exclusive, sources of milk to certain races and communities. Buffalo's milk in particular deserves a more detailed treatment since it is often a more economical dairy animal yielding a richer quality and larger quantity of milk. Data giving a comparative idea of the nutritive values of milks from various milch animals would form a most useful addition to this chapter on the nutritional value of milk.

This monograph is perhaps the only treatise in the English language which deals in a comprehensive manner with the several aspects of dairy science. It is a volume

* *Fundamentals of Dairy Science*, by Associates of ore A. Rogers, Reinhold Publishing Corporation, New York, Second Edition, 1935, pp. 616, $ 6.

which will be gratefully welcomed not only by a number of specialist investigators, the colloid chemist, the biochemist, the physiologist and the bacteriologist, but also by dairy technologists, physicians and food-chemists, interested in the relation of milk to public health and nutrition.

(MISS) K. BHAGVAT.
M. SREENIVASAYA.

The Arachnida.*

SINCE Warburton's article in the *Cambridge Natural History* which appeared as far back as in 1909, no complete account of Arachnida in the English language existed and the present monograph fills a gap in our knowledge of Arthropods.

In the prolegomena considerations like the general characteristics, habits and behaviour and the evolution and classification of the class have been dealt with. Our knowledge regarding many of these problems is by no means complete, but the author, including most of the recent literature on the subject, has made it as up-to-date as possible. Buxton's extensive researches on the coxal glands of arachnids and Millot's investigations into the anatomy and physiology of many arachnids have been incorporated. A consideration of the evolution of the class is not a matter of ease. Conflicting theories like those of Ray Lankester and Pocock, of Zittel and of Leukart, Hansen and Sorensen have made the problem a very difficult tangle from which only a few very clear features emerge. The Trilobita, the Eurypterida and Limulus centre round this problem, and the question ultimately resolves itself to a matter of assigning importance to the fossil remains of the Eurypterida and the Trilobita, and the few forms that stand intermediate between these and Limulus. It need hardly be emphasised that the ancestry of arachnids is closely bound up with the question of the primitive habitat of arachnids and there is no doubt that, should the theory of Leukart, Hansen and Sorensen come to be accepted, there should have to be a complete change in the interpretation of the diverse characters presented by the arachnids. But it is more likely that, if there is one group of animals that will shed more light on this vexed question, it is the Onychophora.

Nor has the classification of the Arachnida been free from changes and this is mainly due to the indiscriminate distribution of many anatomical features among the different orders. The Arachnida, therefore, cannot be divided into orders which can be arranged in an ascending series. A number of schemes of classification have been examined by the author who finally adopts Pocock's scheme, with this alteration, that he excludes the Trilobita from the Arachnida on the ground that they are primitive Crustacea.

The Xiphosura has been treated with a thoroughness which it richly deserves. The only group of primitive arachnids which is surviving to this day, it also includes the only marine forms. A chapter is devoted to each of the other orders, whose anatomy, distribution, classification and diagnostic features are described. Of these the Recinulei stand out with great prominence. This group of arachnids whose rarity is great and whose importance is hardly less, seems to be the only one where the animals possess no type of sense organ and carry their genitalia in their tarsi. Only 32 living specimens are known and as the author says "the future of this group may well hold surprises in store".

Two chapters are devoted to extinct arachnids, of which the Eurypterida are the most important. The position of the Trilobita is also discussed, the author being definitely of opinion that they are primitive Crustacea.

Our knowledge of the Pycnogonida, Tardigrada and Linguatelida has not advanced further after the article by Warburton in the *Cambridge Natural History* and even in 1935 the author of a treatise on Arachnida has to treat them as "doubtful arachnids". The Tardigrada have the least justification for inclusion amongst the arachnids.

But for Mr. Savory's long chapter on economic arachnology, one would have thought that these animals were of no economic importance. He has given a variety of ways in which the Arachnida influence the lives of men. The ticks and mites, the spiders

* *The Arachnida.* By Theodore H. Savory. Pp. xi+218, 8 Plates. (London: Edward Arnold & Co. 1935.) 25 *sh.* net.

and scorpions and even Limulus seem to contribute to this importance.

In a work on the Arachnida and for that matter, on any Arthropod class it is impossible to avoid extensive classification and the monotony of this has been successfully dispelled by the "excursus" which the author appends to every chapter. Many of these are full of interest to the layman, and all to the naturalist. In one, on "The Arachnida as formidable animals" (page 113), the author discusses the psychology of fear and accounts for the terror that spiders and scorpions infuse in our minds as due to the rapid movements that these animals exhibit. While granting that rapidity of movement is one of the contributory causes of fear, it should be said that it is only one of the causes. Nor is it a reason in all cases of fear. A swiftly darting bird does not infuse terror and after all, a dead scorpion induces fear just as much as a moving, very much alive one. Several other topics of general interest are dealt with in these little essays and the book closes with a full bibliography and a complete index.

B. R. S.

Functions and Organisation of the India Meteorological Department.*

IN an interesting pamphlet entitled "Functions and Organisation of the India Meteorological Department, 1935," the Meteorological Office, Poona, has summarised the various functions of the Department and has described briefly the organisation that exists at present for carrying on these duties. The list is comprehensive and contains all the important phases of the work usually dealt with by similar institutions in other progressive countries. Increasing attention has, of late, been given to the problems of upper air, chiefly owing to their importance in connection with aviation; but it is admitted that the meteorological service for this purpose still falls short of the minimum recommended by the International Convention.

Besides meteorology, the activities of the Department include some branches of allied sciences such as seismology and terrestrial magnetism. Thus geophysical researches form part of the routine duties at the Colaba and Alibag Observatories while the Observatory at Kodaikanal, South India, specialises in the study of solar physics and has undertaken some work in co-operation with the International Astronomical Union. Mention is made also of the seismographs that have been maintained at a few stations for the systematic recording of earthquakes.

It is interesting to note that a section for agricultural meteorology has been recently established at the headquarters of the Department, at the Instance of the Imperial Council of Agricultural research. Besides statistical investigations, the section makes a special study of microclimatology and generally carries on researches on problems affecting the welfare of the crops. In view of the supreme importance of this branch of the subject to an agricultural country like India the results of these investigations will ultimately prove to be of considerable practical value. A brief outline is also given of some features of the developments that are contemplated as soon as financial conditions permit; and the note concludes with four appendices giving extracts relating to meteorology from the proceedings of International Conventions and the Royal Commission on Agriculture in India.

* Functions and Organisation of the India Meteorological Department. 1935. Meteorological Office, Poona.

The Indore Meeting of the Science Congress.

ARRANGEMENTS are now actively in hand for the forthcoming meeting of the Indian Science Congress Association in Indore. As usual, the date of the meeting is from the 2nd to the 8th of January, 1935, thus enabling members to avail themselves of the Christmas concession on the railways. In addition, the railway authorities have been approached with regard to granting further concessions, but their decision in the matter will not be known until after the Railway Association has met at Simla in October.

The meeting is being held under the patronage of H. H. Maharajadhiraj Raj Rajeshwar Sawai Shree Yeshwant Rao Holkar Bahadur, Maharaja of Indore. In accordance with the alteration which was made last year in regard to the President's term of office, Dr. J. H. Hutton will remain President of the Association until he hands over his office at the Inaugural Meeting to the President-Elect, who is Rai Sir Upendranath Brahmachari, Bahadur, Kt., M.A., M.D., Ph.D., F.S.M.F., F.A.S.B.

At the last meeting of the Congress, held in Calcutta, two alterations were made in the list of Sections. The name of the Geology Section was changed to "Geology and Geography," thus indicating that papers on geography would be accepted; while a new section for Physiology was added, thus bringing the number of Sections upto 10.

The names and addresses of the Sectional Presidents are as follows:—

1. *Mathematics and Physics.*—Dr. T. Royds, D.Sc., Director, Kodaikanal Observatory, Kodaikanal, S. India.

2. *Chemistry.*—Dr. P. C. Guha, D.Sc., Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
3. *Geology and Geography.*—B. Rama Rao, Esq., M.A., Mysore Geological Department, Bangalore.
4. *Botany.*—Dr. S. R. Bose, D.Sc., F.R.S.E., F.L.S., Professor of Botany, Carmichæl Medical College, Belgachia, Calcutta.
5. *Zoology.*—Dr. H. K. Mukherjee, D.Sc., D.I.C., University Professor and Head of the Department of Zoology, Calcutta University, 35, Ballygunge Circular Road, Calcutta.
6. *Anthropology.*—H. C. Chakladar, Esq., M.A., Lecturer in Anthropology, Calcutta University, 28-4, Srimohan Lane, Kalighat, Calcutta.
7. *Agriculture.*—Mr. A. K. Yegna Narayan Aiyer, M.A., Dip. in Agri. (Cantab.), N.D.D., F.C.S., Retired Director of Agriculture, Sankarapuram, Bangalore.
8. *Medical and Veterinary Research.*—Lt.-Col. H. E. Shortt, I.M.S., Director, King Institute, Guindy, Madras.
9. *Physiology.*—Dr. W. Burridge, D.M., M.A. (Oxon.). Professor of Physiology, University of Lucknow, Lucknow.
10. *Psychology.*—J. M. Sen, Esq., M.Ed. (Leeds), B.Sc. (Cal.), F.R.G.S., Inspector of Schools, Presidency Division, Bengal, 63, Lansdowne Road, Calcutta.

Papers should be submitted to the Sectional Presidents concerned by the 15th of September. A little extra time will be allowed to contributors in the Punjab.

One of the primary purposes of the Association is to encourage scientific work in different parts of India. This year it is meeting in Indore for the first time, and it is hoped that a large number of members will attend and help to stimulate scientific research in that part of India.

Indore, in addition to being fairly centrally situated for scientists from Western and North-western India, offers many attractions both in the City itself and in its immediate neighbourhood. Owing its origin to the great movement for Mahratta imperialist expansion of the 18th century, Indore at present enjoys the premier position among the States included in the Central India Agency.

The City of Indore is situated 1,738 feet above the sea-level and has a delightful climate and moderate rainfall. It ranks amongst the great industrial towns of India, having flourishing cotton-mills and an expanding population now estimated at about 1,50,000 people. It is an important educational centre, containing two first-grade colleges (one of which is maintained by the State), a number of high schools for boys and girls and other institutions. In the Civil Area are situated the Daly College (an institution for the sons of Chiefs), which is a fine building of white marble, the Plant Institute, and a Medical School. Indore also contains many places and buildings worth seeing. A few miles from the City is Badarkha, where up-to-date water works (with the largest siphon system in the world) are nearing completion.

About 60 miles from Indore and situated in Dhar State is Mandu, a favourite haunt of tourists and students of India's past history. Once the proud capital of the independent Muslim kingdom of Malwa and a fort of unparalleled natural strength, it now contains extensive ruins of mosques, palaces and other buildings of great architectural merit. Not far off from it is Bagh (in Gwalior State), which is famous for its rock-cut caves of great antiquity. About forty miles to the south of Indore is Mandhata, an island of superb natural beauty in the Nerbudda river, the early capital of Indore State, which contains a palace and a marble statue of the saintly Ahilya Bai, one of the most illustrious rulers of the State and of India. Not very far off from Indore and easily connected by railway are Ujjain, one of the most ancient and sacred cities of India, Sanchi (in Bhopal State) with its famous stupa supposed to date from the time of the great Asoka, Chitore the most historic place in Rajputana, and the world-celebrated Ajanta caves.

The Local Secretaries will be Dr. S. S. Deshpande, Vice-Principal and Professor of Chemistry, Holkar College, Indore, and Mr. K. A. Patwardhan, Daly College, Indore, to whom all enquiries as to accommodation should be addressed. It is particularly requested that very early intimation of the accommodation required should be sent to the Local Secretaries.

W. D. WEST.

Sir Richard Arman Gregory, Bt., F.R.S. and Dr. Arnold Berliner, Dr.Phil.

WE are glad to announce that Sir Richard Gregory and Dr. Arnold Berliner have accepted our invitation to act as Associate Editors of *Current Science*, and we have no doubt that this news will give widespread satisfaction among those interested in the progress of the Journal.

We have had the privilege of meeting Sir Richard and Lady Gregory during their visit to this country in January and February of 1933 and of discussing with him about the affairs connected with *Current Science*. We need hardly say that we are deeply indebted to him for the numerous suggestions which he offered at the time, and since his return to England, he has maintained his interest in this Journal.

Dr. Arnold Berliner has not visited India but we hope that he will be able to come over at an early date and spend a pleasant time among his numerous friends in this country. We would be glad to offer welcome to him on behalf of our numerous readers and there will always be generous hospitality for him in this country.

The service which Sir Richard Gregory and Dr. Arnold Berliner are rendering to the cause of Science is indeed conspicuous. Their association with their respective Journals during the past thirty years or more has rendered the publications unique. To every Scientist *Nature* and *Naturwissenschaften* are as familiar and indispensable as the objects by which they are surrounded in their Laboratory. Their knowledge and experience will be of great assistance to us in shaping the destiny of *Current Science* and when this assistance is coupled with the advice and co-operation for which we are always indebted to the members of the Board of Co-operators, *Current Science* is bound to become the Indian counterpart of *Nature* and *Naturwissenschaften*,

Research Notes.

Effect of Simultaneous Electric and Magnetic Fields on Spectral Lines. I. Crossed Fields.

A STUDY of the effect of magnetic fields (Zeeman Effect) and of electric fields (Stark Effect) has been a guiding adjunct in the classification of spectral lines and the theoretical investigations of these effects have been of fundamental importance in the development of Quantum Principles. The simultaneous effect of magnetic and electric fields on spectral lines has now been investigated by W. Steubing and the results are reported in the *Sitzb. d. Preuss. Akad. d. Wiss. Berlin*, 1935, p. 3. We shall here summarise the effect observed when the magnetic and electric fields are perpendicular to each other. In every case the pattern due to the electric field is altered by the introduction of the magnetic field. The following regularities have been observed :

(*a*) The *p*-components of the electric field are affected.

(*b*) Such series lines as have a large Stark effect are very sensitive to the magnetic field while those that show small Stark splitting exhibit only a Zeeman effect. However, the separation produced is sometimes larger and sometimes smaller than that due to the normal Zeeman effect. The variation from one series to another is more than double for the same electric and magnetic fields.

(*c*) The lines of the sharp series, so far at least as the first members are concerned, separate as in the pure Zeeman effect, apart from an alteration in the intensities of the components. Similarly the lines due to forbidden combinations which appear under the electric field show only the Zeeman effect. The effect on the principal series is intermediate between that on the sharp series and the effect observed in the diffuse series.

(*d*) In the case of the diffuse series, the number of components produced by the electric field remains unaltered, but the lines broaden out asymmetrically, so that those on the longer wavelength side widen towards the red while the lines on the shorter wavelength side broaden towards the violet. These widened bands have no structure. The bands have a sharp edge on one side and trail off on the other side and have a width about five times the maximum Zeeman separation of the same line.

(*e*) Both in the diffuse series and in the principal series, the broadening increases with the total quantum number. The inner components are less broadened than the outer.

(*f*) The crossing of the fields does not give rise to any new lines.

(*g*) The effect of a magnetic field below 10,000 oersteds is small, but above 20,000 oersteds its effect is more marked than that due to an electric field of 100,000 volts per centimetre.

T. S. S.

The Ferromagnetism of Gadolinium.

THE only known ferromagnetic elements were until recently iron, nickel and cobalt but now another has been added to the family thanks to the labours of G. Urbain, P. Weiss and F. Trombe (*Comptes Rendus*, 1935, **200**, 2132). This new member of the ferromagnetic group is the rare earth metal Gadolinium recently isolated in great purity by F. Trombe. The only impurities were 0·7% of silicon and 0·03% of iron. Small quantities of this precious metal had to be employed and the methods developed at Strasbourg for handling quantities of the order of 0·12 grm. were found most serviceable. Gadolinium was found to be even more ferromagnetic than iron but only at low temperatures. Its Curie point above which the ferromagnetic character is lost happens to be $16° \pm 2°$ C. so that it is only at low temperatures that its ferromagnetic character would be displayed. The specific magnetisation σ varies with the field according to the equation $\sigma_H = \sigma_\infty (1 - a/H)$ and its behaviour from the boiling point of liquid nitrogen, *viz.*, 77° K. to the Curie point shows its great magnetic reluctance, for the constant a in the above equation has the value 1250 while for iron it is below 10. At 77° K., however, its specific magnetisation reaches a larger value than that for iron beyond about 15000 gausses. The absolute saturation value calculated from a T^2-law which is found to hold even below 77° K. comes out to be 253·5 C.G.S. units while for iron it is 221·7. The atomic moment of Gadolinium is 35·4 Weiss magnetons while it is only 11 Weiss magnetons in the case of iron.

T. S. S.

The Growth of Crystals.

ALTHOUGH a considerable amount of information has been accumulated on the nature and constitution of crystalline materials, not much is known about their actual mode of formation and other details regarding their growth. An interesting and convenient method of studying the evolution of crystals is to follow the changes in the interference colours of thin crystals. Preliminary observations have been made on these lines by Perrin, Marcelin and others, who found among other things, that the increase in thickness is a discontinuous process, the smallest step being of molecular dimensions. L. Kowarski has taken up a further detailed examination of this interesting subject, and the first qualitative studies on the formation and growth of *p*-toluidine crystals by controlled sublimation, are reported in *J. de Chimie Physique*, 1935, **32**, 303. According to the state of the support, a razor blade, the sublimed crystals may be single, of uniform thickness, and possessing freely curved contours (curved region); or else, they may be in groups and aggregates in each of which there is a fixed orientation and stratification (oriented region). In this region, the appearance of the crystals is very complex, and the growth is particularly active in regions of recent formation (buds). On rapid heating small drops of liquid appear on the crystal surfaces. A number of phenomena indicate a reciprocal relationship between the movement of these drops and the intensity of crystal growth.

Metallic Membranes.

FOR the study of permeability and membrane equilibria, collodion membranes possess many valuable properties, but have the characteristic of taking up only a negative charge in aqueous solutions. It is however frequently desired to have a positive charge on the membrane, and this is achieved by such devices as loading the membrane with different dyestuffs. In this process not only the sense of the potential but also the whole complex of surface forces are altered. The corresponding method of charging amphoteric membranes (*e.g.*, gelatin) by changing the pH of the solutions has also similar complications. To get over this difficulty and to get a membrane whose change can be easily changed, N. V. Kultascheff and F. A. Santalow (*Z. anorg. allgem. Chemie*, 1935, **223**, 177) have studied the preparation and properties of metallic membranes. These membranes are successfully prepared by heating a thin foil of an alloy of two metals (*e.g.*, brass) so that the more volatile component evaporates leaving behind a membrane with pores of nearly molecular dimensions.

Atomic Weight of Protactinium.

THE atomic weight of not a single member of the Actinium series has so far been determined by purely chemical methods. Aston's work on Actinium D has no doubt given the value for the atomic weight of Protactinium as 231. In spite of the difficulties in getting appreciable quantities of Protactinium, A. V. Grosse (*Proc. Roy. Soc.*, 1935, **150**, 363) has prepared the double fluoride K_2PaF_7 in the highest state of purity, and after careful conversion to Pa_2O_5 found the ratio $K_2PaF_7 : Pa_2O_5$. He gives the mean value for the atomic weight of Pa as 230·6 with an accuracy of ±0·5. This precision determination of atomic weight is of importance in fixing up the atomic weights of the other members of the actinium series.

M. P. V.

Surface Tension of Aqueous Solutions of Electrolytes.

G. JONES AND W. A. RAY (*J. Am. Chem. Soc.*, 1935, **57**, 957) find that the surface tension of a sufficiently dilute solution of an electrolyte is *lower* than that of water itself. This observation is of great interest, if it is confirmed and shown to be a general phenomenon; and is of particular importance as it is not in accordance with the theories developed by Wagner and later by Onsager and Samaras.

K. S. G. D.

On the C—C Bond Energy.

W. LASAREFF has recently made a calculation of the C—C bond energy in diamond and aliphatic molecules (*Physica*, 1935, **2**, 737) which widely departs from the accepted values. He has argued that a carbon atom is in the (^5S) state while a carbon atom in the gaseous state is in the (^3P) state ($\Delta E = 97 \pm 5$ k. cals.) and that the difference between the energies of these two states has to be considered when calculating the C—C bond energy by means of the data regarding the sublimation heat. Lasareff's value for the bond energy in diamond is 132±3·5 k. cals., while the accepted value is about 75 k. cals.

Lasareff has also calculated the bond energy in the aliphatics which comes to 128 k. cals. It is clear that this calculation of the C—C bond energy will lead to important consequences for many problems in chemical calculations.

N. S. N.

Vitamin K.

THE nature and distribution of a vitamin, possessing curative properties against a deficiency disease resembling scurvy in chicks, but which cannot be prevented by ascorbic acid, has been described by Henrik Dam (*Biochem. J.*, 1935, **29**, 1273). The factor is designated Vitamin K, and constitutes the anti-hæmorrhagic factor (or factors) in the diet. It is fat soluble, being found in the easily soluble non-sterol fraction of the unsaponifiable matter. It occurs in hog liver, hemp seed, and in certain vegetables like tomatoes, kale and orange peel. It is different from Vitamins A, D and E; cod-liver oil is practically devoid of it. There is an enormous retardation of the clotting of the blood of chicks suffering from this hæmorrhagic diathesis, and the quantitative estimation of the Vitamin is based on the determination of the clotting time.

Asexual and Sexual Reproduction in Ascidians.

N. J. BERRILL (*Journ. Morph.*, 1935, **57**, No. 2), as a result of the comparative study of a number of ascidians, has come to the conclusion that the processes of bud development and sexual development are, in the ascidians, at variance. Initial bud masses may consist of cells varying from 40 (Distaplia) to 1,000 or more (Ectinascidia) and in all cases the cells undergo a number of cleavages before differentiation begins. Gross differentiation into parts of the organism occurs first and only later cytological or cellular differentiation is seen. In sexual development cleavage and differentiation are fundamentally dissociable, the rate of cleavage and the number of cells produced dependent on the yolk-cytoplasm ratio and the size of the egg respectively. Often in early development the differentiation noticed, refers not to the differentiation of the adult structure but to the precocious differentiation of peculiar larval structures. In some cases a telescoping of the differentiation of the larval structures takes place, without, however, affecting the development of adult structures. The author concludes that the difference between asexual and sexual reproduction really consists in the presence of a larval organisation in the latter, whose differentiation is due to the liberation of substances in the egg during maturation. The rest of the egg unaffected by this substance and which must solely be responsible for the development of the adult organism is usually small and repeated division must precede the differentiation of adult characters.

Development of *Patella vulgata*.

THE embryology of *Patella* is, in spite of the earlier memoirs of Wilson and Patten, still incomplete and in a number of respects our knowledge of this subject is inaccurate, as shown by F. G. W. Smith in his latest paper [*Phil. Trans. Roy. Soc. Lond.*, 1935, **225**, No. (B) 520, 95–125]. The divergence of opinion between Wilson and Patten regarding the origin of endoderm and mesoderm cells is cleared by the present author who states that the whole of the macromere in the quadrant D gives rise to mesoderm while the macromeres of quadrants A, B and C alone give rise to the endoderm. The foot arises in the form of single median protuberance. The development of the radula is for the first time completely followed and it is seen that the radular formula undergoes two changes before it assumes the adult arrangement. The entire process of torsion is described as well as the changes during metamorphosis.

A Petrographic Use of Fluorescence.

TILL now the property of fluorescence has been used for the determination of individual minerals. But recently Alonzo Quinn (*American Mineralogist*, Vol. **20**, No. 6) has shown that such a study could be extended to identify the textural relationships in igneous rocks, if they are photographed in ultra-violet light under special conditions. In connection with his study of the nephelite syenite, he has reproduced several such photographs where the distinction between the minerals is very clear. The hornblende is black, sodalite white and felspar and nephelite grey, thus showing that sodalite was the fluorescent mineral. Though such an investigation involves the employment of different types of films, filters and other specialised appliances for different rocks, yet the method will have considerable value

in the determination of textural relationships of minerals—especially fluorescent—in rocks.

Differentiation in Hawaiian Lavas.

At the present time a good deal of work has been done on the crystallisation of basaltic magma. For most of the American petrographers Hawaiian lavas have become the common material for petrographic work, and Barth's work on the rocks of the Hawaiian Islands has become classic, and his conclusions are in keeping with the experimental deductions of Bowen. But recently Howard A. Powers (*American Journal of Science*, V Series, No. 175) with an intimate knowledge of the Hawaiian volcanoes and lavas, has drawn attention to certain features which vitally affect the theories of magmatic differentiation. He has been able to trace a definite relation between magmatic differentiation and cycles of volcanic activity, and opines that "basalt of uniform composition represents essentially undifferentiated primary magma and the occasional eruptions of the decadent stage bring to the surface the various products that result from the differentiation of the original magma". With regard to the crystallisation of the pyroxenes in basalts he differs from Barth and holds that diopside phenocrysts do not form in primary magma and that orthorhombic pyroxenes should not be omitted from the sequence of pyroxenes in basalts.

Discussing the problems of magmatic differentiation so far as it applies to Hawaiian lavas, he has shown that different phases of volcanic activity produce different types of basalts from the most undifferentiated lime-basalts to the most highly differentiated nephelite-melilite basalt. In conclusion he suggests that "fractional crystallisation alone is not sufficient to explain the differentiation of the Hawaiian lavas".

Science Notes.

Growth of the Shoot in Asparagus racemosus *Willd.*—Mr. S. Sarup writes:—The elongation of the shoot of *Asparagus racemosus* Willd. is very rapid in the beginning, attaining a definite length before the axillary shoots begin to grow. Four shoots in a single young plant reached 80·5 cms., 76·7 cms., 75·9 cms. and 83·0 cms., in about a week's time. This height varies with the age, and the size and number of rhizomes. It was 300 cms. and 150 cms. in two other plants of different ages. In a young plant of *Asparagus sprengerii* the three shoots reached 29.1 cms., 32.0 cms., and 27.2 cms., respectively.

Growth of the shoot of Asparagus racemosus: *increase in cms. after every 12 hours.*

1st shoot								4.7	6.0	3.3	6.3	6.5	6.7	7.6	6.5	5.2	5.9	1.6	
2nd shoot					4.9	3.8	4.8	6.7	6.0	7.7	6.6	8.4	8.7	7.3	7.9				
3rd shoot	1.0	2.0	2.0	3.0	4.0	5.8	4.4	5.8	4.1	5.9	4.2	7.8	7.5	2.5	6.9	6.0	5.5	1.5	1.6
		Slow					Rapid				Max.					Slow			

The growth rate is slow in the beginning, then it becomes rapid until it attains a maximum when it gradually falls off. Taking the actual figures in one case (3rd shoot) we find that the rate of growth rises slowly in the early stages, then it becomes more rapid till it goes up to 7.8 cms. and 7.5 cms. every 12 hours and then it falls to 6.9 cms. for 12 hours. Then it begins to decrease a little till it falls from 5.5 cms. to 1.5 cms. The figures for the other shoots follow the same course.

The readings in the last column were begun as soon as the shoot tip had just come out of the earth and the observations were continued till the axillary shoots were developed. Some discrepancies are due to the fact that external conditions were not uniform.

There appears to be a periodicity in the day and night rates of growth. The suggestive figures for the 2nd and 3rd shoot are like this:—

2nd shoot	..	4.8	6.7	6.0	7.7	6.6	8.4		
3rd shoot	..	4.0	5.8	4.4	5.8	4.1	5.9	4.2	7.8
Shoot of *Asparagus sprengerii*	..	1.2	4.2	1.7	3.2	1.8	1.6	1.2	

In *Asparagus racemosus*, the rate of growth is about 25 per cent. higher in the day than in the night. During the day the plant is adding new material continually (*cf.* Blackman, V. H., *Annals of Bot.*, **33**, 353).

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The Quaternary System CaO-Al_2O_3-SiO_2-Fe_2O_3 in Relation to Cement Technology Building Research Technical Paper No. 16. His Majesty's Stationery Office (Post Free 1s. 1*d.*).—The

demand for Portland cements possessing special properties has caused much attention to be devoted to the constitution of Portland cement and to the content of the various compounds present in it. The present report represents an application to cement technology of the results of a study of a portion of the quaternary system $CaO-Al_2O_3-SiO_2-Fe_2O_3$. The data available from that work permit of a closer definition of the conditions obtaining during the clinkering of a cement raw mix, and of the compound content of the clinker, than has previously been possible.

* * *

Report of the Chemistry Research Board for the Period ended 31st December, 1934—His Majesty's Stationery Office (Price 1s. 8d. Post Free).—The report gives a general review of the activities of the Chemistry Research Board's work started in the Chemical Research Laboratory in 1925. The Director of Chemical Research describes in broad outline the current researches, many of which are conducted with the aid of financial contributions from firms and institutions. In view of the nature of the researches, both academic and industrial, chemists will be interested in this first report which in one volume summarises the results previously published in numerous scattered papers.

* * *

The Relation between Illumination and Industrial Efficiency I. The Effect of Size of Work.—His Majesty's Stationery Office (Price 4*d.* Post Free 5*d.*).—This paper describes the first stage of an investigation the object of which is to find out whether the amount of light required for the efficient performance of the various tasks that have to be carried out in industry can be approximately calculated by examining the separate factors which together make up each visual task. The chief of these factors are size of object, contrast, rate of movement, and possibly colour; and the present paper gives the results of investigation to discover the effect of variations of size upon the illumination required. Further papers upon the relationship of contrast, and rate of movement, with illumination will follow.

* * *

Effect of Storage prior to Ginning on the Spinning Quality of Cotton.—Storage of seed-cotton for any length of time prior to ginning often brings about considerable modifications in the quality of the seed and the lint. The seed is apt to lose in germinating power and the lint to be attacked by bacteria and fungi which are associated to a greater or lesser extent with cotton. There is, however, a school of thought which holds the view that the quality of cotton, stored in seed, improves as a result of a sort of conditioning process during which the development of the fibre continues and some of the oil from the seed flows into it making it soft and pliable and thereby improving its spinning quality. This subject is fully discussed in the latest bulletin of the Indian Central Cotton Committee entitled *Effect of Storage prior to Ginning on the Spinning Quality of Cotton*, by Dr. Nazir Ahmad, M.Sc., Ph.D., F.Inst.P., Director, Technological Laboratory, Indian Central Cotton Committee. The author points out that in spite of the practice of storing cotton in seed, no experiments have so far been reported to test the validity of the above-mentioned views. He then gives an account of the experiments undertaken by him at the Laboratory which show that the storage of cotton in seed before ginning has no effect whatever either upon its mean fibre-length or fibre-weight per inch, showing that there is no justification for the view that the development of the fibre continues during storage. The results of spinning tests and wax determination on three Punjab cottons, *viz.*, Punjab-American 289F, Punjab-American 4F and Mollisoni, revealed that in the case of two cottons storage of seed-cotton before ginning did not bring any improvement either in the wax content or in the spinning performance. In the case of one cotton only, namely P.A. 289F, a small improvement in wax content and spinning performance was observed, but it would be rash to regard it as an argument in favour of delaying the ginning operation and to ignore the harmful effects of storage upon the quality of seed and lint. Giving overwhelmingly strong reasons against the practice of storing the seed-cotton, the author is of opinion that, if by force of circumstances, it should become necessary to store the seed-cotton for a while before ginning, every precaution should be taken to ensure the dryness of the sample, the absence of large quantities of dirt or trash and the absence of a particularly warm or humid atmosphere in the store room. If the period of storage should exceed a few weeks the seed-cotton should be occasionally taken out and exposed to sun. The booklet, which is available at the nominal cost of annas eight, has the rare feature of being useful to all interested in cotton industry, and for the production of which the author should be congratulated.

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Indian Central Cotton Committee.—The 31st meeting of the Indian Central Cotton Committee was held on the 19th and 20th August, 1935, at the headquarters of the Committee, Vulcan House, Nicol Road, Ballard Estate, Bombay, under the presidency of Dewan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman of the Imperial Council of Agricultural Research, His Excellency the Governor of Bombay addressed the meeting.

Numerous questions of vital importance to the cotton industry in India were discussed. The agenda of the meeting included items on the formation of a compact block of long staple cotton in Sind and Government of Bombay's resolutions thereon; licensing of gins and presses; standardisation of weights for cotton transactions; proposed additions and amendments to the bye-laws of the East India Cotton Association Ltd., relating to cotton options and the scheme for the publication of cotton forecasts. Broadcasting in the mornings of commercial news on cotton; railway freight rates on cotton and the mixing of Punjab-American cotton were also discussed.

In addition to the above, as is usual at the monsoon meetings the Committee reviewed the progress made on its various research and seed schemes.

Among the new schemes proposed to be introduced are (1) scheme for introduction and extension of B.D. 8 cotton in Broach district, (2) scheme for extension of cultivation of long staple cotton in Bengal, and (3) revised seed schemes for the distribution and extension of Jaywant and Gadag

No. 1 cottons in the Southern division of the Bombay Presidency.

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Biochemical Society, Calcutta.—At the Annual General Meeting of the Biochemical Society, Calcutta, held at the All-India Institute of Hygiene on July 11, the annual report of the Secretary and Treasurer was presented by the Secretary, Dr. B. C. Guha. In course of the report, the Secretary said "The Biochemical Society, Calcutta, was inaugurated in a meeting held at the All-India Institute of Hygiene on July 6, 1934. The need of such a Society for the promotion of biochemical studies and research had been felt for some time and it was hoped that the creation of such a scientific body in Calcutta would evoke local response. In this expectation the promoters of the Society have been fully justified. The record of last year's work shows good progress and stimulates hope for the future."

Since the inauguration of the Society in July, 1934, ten meetings have been held in which the following fourteen papers have been read and discussed. The papers display a wide range of interests.

(1) B. Ahmad—The Metabolism of Carotene. (2) A. C. Roy—Cultivation of micro-organisms on vegetable media. (3) S. C. Banerjee and H. K. Sen—Catalytic activation of diastase. (4) R. C. Bhattacharjee—The therapeutic applications of snake venom. (5) A. R. Ghosh and B. C. Guha—Vitamin C in Indian foodstuffs. (6) B. Ahmad—The excretion of Vitamin C in human urine. (7) P. C. Mitter and N. N. Chatterjee—The formation of purines from iminazoles. (8) B. N. Ghosh—The combination of antigens with anti-bodies. (9) N. R. Chatterjee, D. N. Chatterjee, Pasricha and S. Ghosh—Effect of bacteriophage on the enzyme activity of vibrio choleræ. (10) A. C. Roy—Biochemistry of snake venom. (11) J S. Chowhan—Therapeutic uses of snake venom. (12) B. C. Guha and H. G. Biswas—Flavines and Vitamin B_2. (13) B. C. Guha and A. R. Ghosh—The biological synthesis of ascorbic acid. (14) H. E. C. Wilson and S. L. Mukherjee—Some observations on the composition of the urine in relation to calculus formation.

At the annual meeting, the following papers were read:

(1) N. Das and B. C. Guha—The respiration of *Bact. Staphylococcus*.

(2) A. R. Ghosh and B. C. Guha—The relation between dietary composition and the urinary excretion of ascorbic acid.

For the next year the following have been elected to form the Committee:

Mr. N. M. Basu, Dr. P. K. Bose, Dr. P. De, Dr. J. N. Mukherjee, Dr. S. N. Ray, Mr. A. C. Roy, Dr. B. B. Sen and Dr. H. E. C. Wilson. Dr. S. Ghosh and Dr. B. C. Guha have been elected Honorary Secretaries and Dr. B. Ahmad, Honorary Treasurer.

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Association of Economic Biologists, Coimbatore.—A meeting of the Association was held on the 26th June 1935. Two interesting papers were read:—(1) Intercultivation in dry cottons by V. Ramanatha Ayyar; (2) Effect of certain cultural practices on the cocoanut by J. S. Patel and K. W. Chakrapani Marar. On 22nd July 1935, Mr. W. B. Gurney, Entomologist, New South Wales, Australia, delivered an interesting lecture on "Some aspects of Economic Entomology in Australia". On 29th July 1935, Dr. E. K. Janaki Ammal read an illuminating paper on "Cytogenetic studies in *saccharum Spontaneum* L."

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Academy of Sciences, U.P.—The ordinary monthly meeting of the Academy was held on Saturday, April 20, 1935, at 9-30 a.m. in the Physics Lecture Theatre under the presidency of Prof. N. R. Dhar and was attended by a large number of members. The following were elected new members of the Academy:—Drs. Rangadhama Rao and Ramkrishna Rao of the Andhra University; Profs. N. R. Sen and P. C. Mahalanobis of the Calcutta University; Dr. D. N. Wadia, Geological Survey of India; Prof. Ajrekar of the Guzarat College; Dr. Rangaswami Ayyangar of the Rice Research Institute, Coimbatore; Dr. Normand, Director-General of Meteorology; Rao Bahadur B. Viswanath, Imperial Agricultural Chemist, Pusa; Prof. Mowdawalla, Principal of the Government Engineering College, Bangalore; Lt.-Col. R. N. Chopra, Principal, School of Tropical Medicine, Calcutta; Mr. Champion, Silviculturist, Dehra Dun; and Mr. Pinfold of the Attock Oil Company.

The President made a short speech reviewing the progress of the Academy. He said that in view of the increasing number of papers received by the Academy, the Bulletin has been converted to Proceedings. It is gratifying to find that the publication has been much improved, and it is now quite regular. The position of the Academy has been recognised by foreign learned bodies like the Academy of Sciences, France, the Prussian Academy of Sciences, the National Academy of Sciences of America, the Royal Society of Edinburgh, the Imperial Academy of Sciences, Japan and about a hundred other bodies which are regularly exchanging their publications with ours. The Council has recommended that a temporary officer be appointed next year to deal with the publication and quick despatch of business. The Academy has been recognised to be an all-India body by the Indian Science Congress, and it is gratifying to find that a large number of Scientists of repute from other parts of India have agreed to join the Academy.

In view of the changed circumstances, the President remarked that the Council of the Academy has decided to widen its scope of activities, and has redrafted the existing rules and regulations. It has been decided to increase the number of Fellowships to one hundred and change the name to "National Academy of Sciences, India". These proposals are now being circulated amongst the members, in accordance with company rules, and after the usual ceremony, will be placed before the Academy for final sanction.

The Government of the United Provinces has very kindly sanctioned a recurring grant of Rs. 2,000 per year, and appeals have been made to other Governments and learned bodies for financial grants to enable it to cope with its increased activity. The President hopes that in view of the increasing usefulness of the Academy to the country, these appeals will meet with response. The Academy is already finding its accommodation cramped and an appeal for a building fund will shortly be issued.

About a dozen papers were read before the Academy. The President read a paper in which

he showed that the addition of molasses to the soil considerably aids the fixation of nitrogen and this is ascribed partly to the action of light in the tropics. Dr. S. Dutt described the isolation, analysis and the synthesis of the active principle of an Indian Medicinal plant *Glycosmis pentaphylla* which is highly recommended by the Indian physicians for a number of diseases. Mr. Satyendra Ray's paper on a modified theory of gravitation base on Sulaiman's theory provoked very active discussion and his assumptions and method of work were criticised by Dr. Kothari from Delhi and Dr. Mazumdar from Lahore. Messrs. Agarwal and Dutt described the results of their analysis of the bark of *Terminalia arjuna*, a plant of great medicinal use. Messrs. Toshniwal and Pant described the results of their recent measurements of the height of the ionosphere and its electron content. Mr. Bajpai described certain anomalous results which he obtained on the measurement of the height of ionosphere during the total lunar eclipse. Mr. S. P. Jain read a paper on Taylor's Series and Borel's Polygon of Summability.

Mr. Har Dayal Srivastava described a new parasite referable to a new genus of the Subfamily *Dinurinæ*. It is a very rare parasite in the stomach of ilisha fish. In another paper Mr. Srivastava gave an account of a new member of the family *Monorchidæ* from sauri fish. Mr. B. P. Pande read his contributions to the Digenetic trematodes from the microchiroptna of Northern India. Mr. S. C. Varma described new species of *Bucephalopsis* and *Bucephalus* and provisionally created a new genus *Trilentacularia*.

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Report of the Extraordinary Monthly Meeting of the Academy of Sciences of the United Provinces of Agra and Oudh held on Friday, May 10, 1935, at 6 P.M.:—Prof. A. C. Banerji, Vice-President of the Academy, was in the Chair. The following papers were read and discussed:—(1) MESSRS. R. N. GHOSH AND L. P. VARMA, Physics Dept., Allahabad University, Allahabad: *On the Application of Heaviside's method to the Problem of Vibrations of Pianoforte String.* (2) MR. HAR DAYAL SRIVASTAVA, M.Sc.: *New Amphistomatous Parasites from an Indian Freshwater Fish.* (3) MR. HRISHIKESHA TRIVEDI, M.Sc.: *The Absorption Spectra of the Vapours of Oxides of Copper, Iron, Nickel and Cobalt and the Determination of their Heats of Sublimation.* (4) MR. HRISHIKESHA TRIVEDI, M.Sc.: *The Absorption Spectra of the Vapours of the Mono-Sulphides of Iron, Nickel, Cobalt, Copper and Tin, and the Determination of their Heats of Sublimation.*

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Scripta Mathematica: April 1935 (Vol. III, No. 2) R. C. Archibald. "*Mersenne's Numbers.*"—An authoritative paper giving "accurate and complete information concerning present knowledge" of what are known as Mersenne's Numbers —the 55 numbers 2^p-1 where p is one of the primes 2, 3, ..., 257. Indian Scientists will note with an element of delight that V. Ramesam has been quoted as the first to give two of the factors of $2^{71}-1$, *viz.*, 48544121 and 212885833. (*Journ. Indian Math. Soc.*, 1912, 4, 56.)

The same author in a paper which is concluded in this issue gives an up-to-date account of the results which have been obtained in the attempts to prove the famous Goldbach's Theorem.

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The Perpeti Meteorite.—One of the interesting exhibits shown and commented upon by Dr. A.L. Coulson, at the ordinary meeting of the Asiatic Society of Bengal held on Monday, the 5th August 1935, was the Perpeti Meteorite. "At 11 P.M. on the 14th May 1935, a meteoric shower occurred in the vicinity of the villages of Perpeti (23° 19′ 30″ : 91° 0′ 0″), Bhateswar, and Pilgiri under the jurisdiction of the Chandina police station, and near other villages under the police stations of Kachua and Hajiganj, in the Tipperah district of Bengal.

"Eleven pieces in all were recovered. The total weight of all specimens is 21,942·57 grams; the largest one weighs 6,689·85 grams. The specific gravity of the meteorite is 3·554. It is being analysed by Mr. P. C. Roy.

"The meteorite, which has been registered as No. 298, Stone, in the collections of the Geological Survey of India, has been classified provisionally as No. 14, White Chondrite (Cw.) in Brezina's terminology. It has a white, rather friable mass with few, chiefly white, chondri."

* * *

Gift of the International Union of Chemistry.—The last Conference of the Union held in April 1934 in Madrid, eager to help the Committee of the A.T.C. to go on with the work, had agreed to transfer to the Committee an important part of the Funds of which the Union disposes.

This decision was voted unanimously by the Union's Executive in Paris, October last and confirmed by National Organisations representing the various countries at the Union (*e.g.*, Verband Deutscher Chemischer Vereine representing Germany, Comité National Belge de Chimie representing Belgium, National Research Council, Division of Chemistry representing the United States, etc.).

The sum thus put at the disposal of the Committee of the A.T.C. is 150,000 francs. The large amount shows the interest which the international chemical circles attach to the continuation of the A.T.C. This sum will be used up for the printing of the Index of the second series (Vols. VI to X—1923-30), now ready at the Editorial Office.

In compensation of this gift the Committee of the A.T.C. is going to put at the disposal of the chemical organisations adhering to the Union a certain number of complete sets. This number and the mode of their distribution are to be established shortly. (*Communicated by Dr. Ch. Marie, General Secretary of the A.T.C.*)

* * *

A three-year entomological scheme to combat a serious cotton pest due to a black-headed cricket, has been approved by the Sind Cotton Committee, at a recent meeting. The Scheme will be submitted to the Sind Central Cotton Committee for grant of financial aid.

* * *

The Institute of Brewing.—The Collective Index of the *Journal of the Institute of Brewing* for the years 1924–34, inclusive, will shortly be published. The price will be 12*s.* 6*d.* to Members and 25*s.* to non-Members, postage free. Those who are desirous of securing a copy of this publication

may communicate with *The Secretary, Institute of Brewing, Brewers' Hall, Addle Street, London, E. C.* 2.

* * *

New Broadcasting Station at Delhi.—The main details of the new broadcasting station at Delhi, which is to be erected and worked by the Indian State Broadcasting Service are now settled. The transmitting station will be located to the north of Old Delhi on the Ambala Road near the intersection of Probyn Road and the Mall and the construction of the station building will be begun shortly. The frequency response is substantially uniform from 30 to 10,000 cycles per second, which will give reproduction of a very high standard. The wavelength chosen for initial working is approximately 340 metres, the precise frequency being 882 kilocycles per second. In order to obviate any possible interference to be caused to reception of Indian stations in India by high power broadcasting stations in Europe and other parts of the world, particularly at night and at the extreme range of the Indian stations, a continuously variable valve-type of frequency control has been selected in preference to a crystal, which would not permit of any rapid change of wavelength. The frequency stability of the apparatus chosen is adequate for Indian conditions.

As regards power, the station is rated at 20 kilowatts to the aerial with distortionless modulation of 90 per cent. and the station will thus have an effective power more than ten times that of the present stations of the Indian State Broadcasting Service at Bombay and Calcutta. The aerial system will be of the quarter-wave type and will be supported by two masts 100 metres high, *i.e.*, approximately 330 ft. The masts which are of the stayed lattice type, will be insulated from the ground and their electrical properties can be adjusted in order to increase the radiation in certain directions. This will permit the energy to be directed towards the more densely populated areas which lie roughly to the north-west and south-east from Delhi. The mast alignment has been adjusted to this direction.

It is generally agreed, that in the absence of exceptionally severe atmospherics and interference from electrical apparatus, a field-strength of one millivolt per metre should give reliable reception with comparatively simple receivers. It is estimated that the Delhi station will give this field-strength upto a distance of 85 miles in all directions during the day. Modern receivers will, however, give good results when conditions are reasonably favourable with a field-strength of one-tenth millivolt per metre and the Delhi station is estimated to give this field-strength upto a distance of 240 miles. It is fairly certain that during the cold weather and at other times when conditions are favourable, Lucknow and Cawnpore to the south-east and Lahore to the north-west will be able to receive the Delhi station even during the day time. It is anticipated, however, that on the average, field-strength at night will be about one-third millivolt per metre upto 600 or 700 miles, which will bring within range of Delhi practically the whole of Northern India, including most of the hill stations in the Himalayas.

Apparatus has also been ordered for the fitting of the studios in accordance with the best modern practice, but the precise location for the studio has not yet been decided.

As regards programmes, a service of about 4 hours daily will be provided at first, though this will probably be increased as support is obtained in the form of licences in the neighbourhood. A very substantial portion of the programme will be in Indian languages and based on the indigenous culture of the surrounding area. The proportion of European programmes will depend on evidence of the public taste obtained in practical working. The British Broadcasting Corporation have kindly granted permission to the Indian State Broadcasting Service to relay the programmes of the Empire Broadcasting Service and arrangements will be made to construct a special receiving station near Delhi for this purpose. European programmes of a high quality will thus be available. Arrangements will also be made for items specially directed towards the general uplift of rural districts in the immediate neighbourhood.

It is not possible at this stage to give a definite date by which the station will be working, but it is hoped that experimental programmes will be given in November and that regular programmes will be broadcast well before the end of the next cold weather.—(*Extracted from the Indian Radio Times*, 22nd May 1935.)

* * *

Colloidal Copper for Leprosy.—Dr. William Noble of the Salvation Army in Travancore, as a result of his work in collaboration with Dr. Denny of the Leper Colony, Louisiana, will soon start a new treatment which has already given very good results in the hands of Dr. Denny, for Leprosy. The disease is due to a microbe which occurs only in persons who are pre-disposed due to mal-nutrition and weakness, and is generally caused through other illnesses. By building up resistance and concentrating solely on proper feeding and curing of other diseases, the leprosy microbes not only decreased in intensity but also ultimately disappeared. The treatment is slow compared with the unpleasant chaulmoogra. More recently colloidal copper has been found to be a good substitute for the chaulmoogra. The treatment is rapid and effective and very good results have already been obtained by Dr. Denny by copper injections.

* * *

Ootacamund Observatory.—At the instance of the Ootacamund Municipality, the India Meteorological Department has restarted the observatory at Ootacamund which was in existence from 1901 to 1923. The usual instruments of a III class observatory, *viz.*, a barometer, a Stevenson screen, a set of four thermometers, an anemometer, a wind vane and a rain-gauge, have been loaned by the India Meteorological Department and have been installed at suitable sites under the personal supervision of an officer of the department who was deputed to the station for the purpose in the 1st week of July.

The observatory will be maintained by the Municipality and will be under the technical supervision of the India Meteorological Office. For the present, a copy of the daily meteorological data will be posted by the Municipality to the India Meterorological Office in monthly registers,

Professor A. C. Seward, Professor of Botany, Cambridge University, has been invited by the Indian Universities to deliver a series of lectures at the various educational centres in India.

* * *

We learn with great pleasure that Dr. B. K. Das, Professor of Zoology, Osmania University, Hyderabad (Deccan), having received a special invitation from the International Zoological Congress to be held at Lisbon, is being deputed to attend the same. He will read a paper on "Certain characteristic features of the Hyderabad fauna". Besides, he will also deal with certain important aspects of the Osmania University for which he has been requested by the Congress. He is sailing on the 20th of this month and will be back about the 1st week of November next.

* * *

It is understood that Professor J. N. Mukherjee, of the University of Calcutta, will be deputed by the Imperial Council of Agricultural Research to represent India at the International Soil Science Conference, London.

* * *

Sir Hari Singh Gour and Dr. M. A. Moghe of the Nagpur University will represent the University at the next Quinquennial Congress of Universities of the Empire to be held at Cambridge in 1936.

* * *

The Hon'ble Mr. A. G. Clow, C.I.E., I.C.S., Joint-Secretary, Department of Industries and Labour, Government of India, has been appointed as the first Chairman of the newly created Council of Industrial Intelligence and Research Bureau of the Government of India.

* * *

The Andhra Scientific Co., Ltd., Masulipatam.—We have recently received from Messrs. The Andhra Scientific Co., Masulipatam (S. India), a "check valve" and a reprint of a paper on the device published in the *Journal of the Indian Chemical Society* (1934, 11, 659). The valve constitutes a very simple device for effectively preventing back suction which is a common experience, due to slight diminution in the rate of evacuation, in the laboratory. In actual use, the valve comes next to the pump so that when the pump is disconnected, the reduced pressure in the evacuated space is maintained. This has now been placed on the market and thus made widely accessible.

We also understand that the Company have specialised in the manufacture of special regulator resistance for high output suitable for 120 and 220 volt mains, weight boxes, balances and drying ovens, of standard quality. They are also prepared to undertake manufacture of any new laboratory device from scientific workers.

* * *

We are glad to felicitate Dr. Muhammad Abdul Hameed Siddiqui, Professor of Anatomy, King George's Medical College, Lucknow, on his being awarded the Vincent Massey Scholarship.

Professor Siddiqui took the B.Sc. Degree in 1923, from the Canning College, Lucknow University. He then joined the King George's Medical College, Lucknow, and passed the M.B., B.S. examination in 1928, with distinction in Pathology coming out First in the University. He was the recipient of a University Scholarship and many medals and certificates of honour. In 1930, he took the M.S. degree of the University, being the first candidate to get that degree from the University. He went to Europe for higher studies and in 1931, he obtained the D.L.O. & R.C.S. (Eng.) and in 1932, the F.R.C.S. degrees. In 1932, he was appointed Professor of Anatomy, King George's Medical College, Lucknow, which appointment he is holding to date. In 1933, he went to London for a short period to attend the meetings of Anatomical Society of Great Britain.

* * *

Announcement :—

Woodhouse Memorial Prize, 1935.—Mr. C. A. MacLean, Officiating Director of Agriculture, Bihar and Orissa, writes :—

"In memory of Mr. E. J. Woodhouse, late Economic Botanist and Principal of Sabour Agricultural College who was killed in action in France in 1917, a biennial prize in the form of a silver medal and books of a combined value of Rs. 100 will be awarded to the writer of the best essay on a subject of botanical interest to be selected from the list noted below. The length of the essay should not exceed 4,000 words.

1. Intergeneric hybrids and their importance to agriculture.
2. The problem of rust of wheat in India.
3. The constancy of agricultural and botanical characters of paddy and their suitability for being used in a scheme of classification.
4. Rotation of crops in relation to the eradication of weeds.

The competition is open to graduates of Indian Universities and to Diploma holders and Licentiates of recognised Agricultural Colleges in India, who are not more than 30 years of age on the date of submission of their essays.

Papers should be forwarded to the Director of Agriculture, Bihar and Orissa, Patna, before November 1st, 1935.

Failing Papers of sufficient merit, no award will be made. Essays must be typewritten on one side of paper only.

* * *

We acknowledge with thanks the receipt of the following :—

"Transactions of the Faraday Society," Vol. XXXI, Pts. 1-7, Jan.—July 1935.

"Actualites Scientifiques et Industrielles," Nos. 222, 225, 230-234, 236, 240-248, 254-255 and 264.

"Bibliotheque Scientifique Belge—La Spectroscopie appliquee." (Hermann et Cie, Paris).

"Journal of Agricultural Research," Vol. 50, Nos. 6 and 7.

"The Journal of the Royal Society of Arts." Vol. LXXXIII, Nos. 4309-4313.

"Indian Journal of Agricultural Science," Vol. 5, Pt. II, April 1935.

"The Biochemical Journal," Vol. 29, No. 6, June 1935.

"The American Journal of Botany," Vol. 22, No. 7, July 1935.

"The Journal of the Indian Botanical Society," Vol. 14, No. 1, March 1935 and Index to Vol. 13.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 7, July 1935.

"Canadian Journal of Research," Vol. 12, No. 6, June 1935.

"Chemical Age," Vol. 32, Nos. 834–835; Vol. 33, Nos. 836–838.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 7.

"The Journal of the Indian Chemical Society," Vol. XII, No. 5, May 1935.

"Experimental Station Record," Vol. 72, No. 6, June 1935.

"Indian Forester," Vol. LXI, No. 8, August 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 19, 20/21.

"Department of Commercial Intelligence and Statistics, India—Monthly Statistics of the Production of Certain Selected Industries of India," February 1935, No. 11 of 1934–35.

"An Investigation of the Uplift Pressure on a Model of Bay IV. Khanki Weir and the Prototype," Vol. II, No. 10. (Research Publication: The Punjab Irrigation Research Institute.)

"Study of the Evaporation of Water from a Soil Surface with reference to the Fluctuations of Water-table," Vol. 5, No. 3, Nov. 1934. (Research Publication: The Punjab Irrigation Research Institute.)

"A statistical examination of the Uplift Pressure data obtained from Model experiments," Vol. 1, No. 5, Jan. 1935. (Research Publication: The Punjab Irrigation Research Institute.)

"The Wild Animals of the Indian Empire," Parts I and II. Journal of the Bombay Natural History Society, 1924.

"The Micro Post-Office Journal of the Engineering Association of Ceylon," No. 2, July 1935.

"Report of the Minister of Agriculture," Dominion of Canada, 31st March 1934.

"Tobacco growing in Canada," by N. A. Macræ.

"Farmer's business Organisations in Canada," Bulletin No. 173, New Series.

"Division of Forage Plants," Department of Agriculture, Dominion of Canada, for the years 1930–1933.

"Proceedings of the Academy of Sciences" (United Provinces of Agra and Oudh, India), Vol. IV, Pt. IV, May 1935.

"Indian Lac Research Institute, Annual Report for 1933–34."

"Bulletin of the Geological Institution of the University of Upsala," Vol. XXV.

"Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. LXXXVI, 1934.

"Rothamsted Experimental Station, Harpenden, Lawes Agricultural Trust," Reports for 1930, 1931, 1932 and 1933.

"Journal of the Indian Mathematical Society," Vol. I, No. 5.

"Nature," Vol. 135, Nos. 3425–3428, Vol. 136, No. 3429 and Index to Vol. 135, Jan.—June 1935.

"The Journal of the Bombay Natural History Society," June 1935.

"The Journal of Nutrition," Vol. 9, No. 6; Vol. 10, No. 1.

"The Journal of Chemical Physics," Vol. 3, No. 7, July 1935.

"Indian Journal of Physics," Vol. IX, Pt. 5, and "Proceedings of the Indian Association for the Cultivation of Science," Vol. XVIII, Pt. V.

"Journal de Chimie Physique," Vol. 32, No. 6.

"Research and Progress," Vol. I, No. 3, July 1935.

"The Journal of Russian Chemical Society," Tome V (LXVII).

"Records of Indian Museum," Vol. 36, Pt. IV.

"Science Progress," Vol. 30, No. 117, July 1935.

"Science and Culture," Vol. I, Nos. 2 and 3.

"The Indian Trade Journal," Vol. CXVIII, Nos. 1516–1519.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 3, 1933 (Index).

Academies and Societies.

Academy of Sciences (United Provinces of Agra and Oudh, India):

May 1935. L. P. VARMA: *On the Determination of Absorption Coefficient of Sound for Different Materials.*—Some Absorption Coefficients at 512 frequency for some commercial absorptive materials have been obtained by the Stationary Wave Method of E. T. Paris. The absorption coefficient of embossed metal plate coated with a blue paint (extensively used for ceilings of auditoriums) was found to be 0·25. BINAYENDRA NATH SEN: *On the Direct Formation of Bromides and the Distance of the Closest Approach of Atoms of Bromine.*—The distances of closest approach of atoms of metals determine their capacity to react with bromine. This value should be above 1·73 Å. BRAJ KISHORE MALAVIYA AND SIKHIBHUSHAN DUTT: *Photoreaction in Tropical Sunlight.*—2 per cent. solutions in appropriate solvents of aromatic amines, mono- and poly-hydric phenols, diamines, dyestuffs, aliphatic hydroxy acids, unsaturated acids, aminophenols and their derivatives, amino acids, aldehydes, hetero-cyclic compounds, aromatic oximes, phenylhydrazine and sulphocarbamide, were exposed to sunlight for periods varying from 42 to 156 days. The products obtained have been examined. N. R. DHAR AND S. K. MUKERJI: *Some Aspects of Nitrogen Fixation in Soil.*—The experimental results show that in absence of bacteria, the photo-oxidation of the energy rich compounds leads to the fixation of nitrogen in soils. MOHAMMAD HAMID KHAN: *On Eight New Species of the Genus* Cyclocœlum brandes *from North Indian Snipes.*—For the first time eight new species of the genus *Cyclocœlum* which are exclusively parasitic in the air sacs or the body cavities, have been described. B. P. PANDE: *Contributions to the Digenetic Trematodes of Microchiroptera of Northern India. I.*—Two new species of distomes belonging to the subfamily *Lecithodendriinæ* Looss and to the genus *Pycnoporus*, from the Indian insectivorous bats have been reported. HAR DAYAL SRIVASTAVA: *New Hemiurids (Trematoda) from Indian Freshwater Fishes. I.*—Two new species of *Lecithaster* have been reported from the common fresh water fish, *Clupea ilisha*. P. R. BHAGWAGAR: *Some Polyporaceæ from the Central Provinces.*—From a large collection of fungi made during the rainy season of 1930 from certain areas of Central Provinces, five species have been described. A. T. MOSHER: *Determining Sizes of Mangum Terrace Outlets.*—A formula has been derived for calculating the sizes for open channel terrace outlets for agricultural purposes.

Indian Academy of Sciences:

July 1935. SECTION A.—T. S. WHEELER: *On the Theory of Liquids. IV.*—Equations have been deduced for the forces on a particle vibrating in a spherical space under the influence of attractive and repulsive forces between that particle and uniformly distributed matter outside the spherical space. I. CHOWLA: *Some Problems of Waring's Type (III).* P. RAMA PISHAROTY: *Laminar Diffraction and the Becke Phenomenon.*—A sharp laminar edge appears as a dark line bordered by asymmetric fringes when examined in direct illumination under a microscope. This is explained as due to asymmetric diffraction effects at the edge. GURDAS RAM, V. I. VAIDHIANATHAN AND E. M. TAYLOR: *Potential Distribtuion in Infinite Conductors and Uplift Pressure on Dams.*—The distribution of pressure in the sub-soil under dams is the same as potential distribution in conductors. R. K. ASUNDI AND R. SAMUEL: *The Near Ultra-Violet Absorption Bands of SO_2.*—A number of new bands have been recorded and an analysis interpreting the bands as a uniform system is presented. A. VEERABHADRA RAO: *Raman Spectrum of Carbon Disulphide.*—The intensity distribution in 656 cm.$^{-1}$ is similar to that obtained in the wings accompanying the Rayleigh lines in liquids. R. VAIDYANATHASWAMY: *On the Arithmetico-Logical Symmetric Functions of n Attributes.* S. BHAGAVANTAM: *Hindered Rotation and Oscillation of Molecules in Liquids and in Crystals.*—The small oscillatory motions of liquid molecules about their equilibrium positions may be regarded as incomplete rotations, and this brings out a direct relationship between the optical anisotropy of the molecule and the intensity of the scattered line. N. R. TAWDE: *Some Aspects of Gross Intensities in Electric Bands with Special Reference to C_2 (Swan) and N_2 (Second Positive) Systems.*—The probabilities of transition, the temperatures and the "Centres of Intensity" have been discussed in relation to each other. K. S. KRISHNAN AND S. BANERJEE: *The Entropy of Manganous Ammonium Sulphate at Temperatures close to Absolute Zero, in Relation to the Magnetic Anisotropy of the Salt at Room Temperatures.*—The above relationship and its convenience for calculating θm. the characteristic temperatures are pointed out. S. BHAGAVANTAM: *The Carbon Isotope in Raman Scattering. Part I.*—The shifts 985, 1175 and 974 in benzene, cyclopropane and ethane are attributed to $C^{12}{}_5C^{13}H_6$, $C^{12}{}_2C^{13}H_6$ and $C^{12}C^{13}H_6$ respectively. S. BHAGAVANTAM: *A Suggested New Interpretation of the Structure of Band Spectra.*—It is found that large electric moments have to be postulated to account for the observed changes in the nuclear distances and vibration frequencies of highly polarisable molecules, thus indicating a fundamental relationship between the phenomenon of optical polarisability and electronic excitation. B. VENKATESACHAR AND L. SIBAIYA: *Isotope Abundance in Platinum.*—Exact analysis of the micro-photograms gives the isotopes and their relative abundance as 196 (16), 195 (13), 194 (10) and 192 ($\sim$2).

SECTION B.—L. S. RAMASWAMI: *Contributions to Our Knowledge of the Cranial Morphology of Some Ranid Genera of Frogs. Part II.*—The cranial characteristics of three South Indian aquatic forms of the genus *Rana* have been recorded. S. S. PATWARDHAN: *Three New Species of Trematodes from Birds.*—Three new species belonging to the genus *Neodiplostomum* La Rue, 1926, differing from the known species in the ratio of the fore-body and hind-body and other characters have been described. R. B. KULKARNI: *A Second Species of* Procamallanus *Baylis* 1923 *from India.*—A new species of nematode for which the name *Procamallanus planoratus* is proposed was isolated from the intestine of a Silurid fish, *Clarias batrachus* Bl. B. M. JOHRI: *Studies in the Family* Alismaceæ. *III.*—Sagittaria Guayanensis *H.B.K.* and S. latifolia *Willd.* H. R. BHARGAVA: *The Life-History of* Trianthema monogyna *Linn.*—The microsporogenesis and megasporogenesis of *Trianthema monogyna* Linn., belonging to the family *Aizoaceæ* has been described. S. K. NARASIMHAMURTHY: *The Life-History of* Ottelia alismoides *Pers.* FROILANO DE MELLO AND EMIDIO AFONSO: *Blood Parasites of* Coracias b. benghalensis *with Special Remarks on its Two Types of* Leucocytozoon.—Two species which are autonomous and independent have been described; while one of them may be classified as *Leucocytozoon*, the other has as all the parasites of this type, enough characters to constitute an independent genus to which the name Marcél léger should be attached. G. N. RANGASWAMI AYYANGAR AND K. KUNHI KRISHNAN NAMBIAR: *Studies in* Dolichos lablab *(Roxb.) and (L).—The Indian Field and Garden Bean.* II—The seed coat colours constitute a case of linkage. S. RAMANUJAM AND N. PARTHASARATHY: *An Asynaptic Mutant in Rice* (Oryza sativa).—A mutant occurring in the bulk crop of one of the Coimbatore strains, Co. 4, has been described and observations of its meiosis reported. GOBIND SINGH THAPAR AND MAKUND BEHARI LAL: *On the Morphology of a New Genus of Trematode Parasite of the Kingfisher from Lucknow.*—A new genus *Psilorchis indicus* N.G., N.Sp. has been described. YAGNAVALKYA BHARADWAJA: *The Myxophyceæ of the United Provinces, India. I.*—Twenty-one forms of the algæ, of which seven are new species, three are new varieties and four are new forms, representing ten genera collected from Benares, have been described. C. R. HARIHARA IYER, R. RAJAGOPALAN AND V. SUBRAHMANYAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition. X.—Influence of Different Forms of Manganese on the Oxidation of Organic Matter and Release of Plant Nutrients.*—Treatment with different forms of manganese does not produce any appreciable difference in the quality of tomato. Experiments with varieties of tomato and ragi have convincingly demonstrated the advantages of supplementing organic manures with chemical oxidisers.

The Indian Physico-Mathematical Journal:

April 1935. S. CHOWLA proves that every large number is a sum of eight almost equal cubes—an improvement of a result due to E. M. Wright who had proved that every large number is a sum of *nine* almost equal cubes.

In another paper, S. Chowla improves another result of Wright connected with a Waring problem: If $v(k)$ denote the least value of s such that every integer can be expressed in the form $\sum_{i=1}^{s} e_i m_i^k$, where $e_i = \pm 1$ and m_i is a positive integer

or zero, then Wright had proved that $v(20) \leqslant 185$. Chowla proves that $v(20) \leqslant 161$. A further paper on the same subject by Chowla is to be found in *Quart. Journ. Math.* (Oxford), Vol. 6, No. 22.

Indian Chemical Society:

May 1935. UMAPRASANNA BASU: *Synthesis in the Pyridine Series.* RAJENDRA NATH SEN AND B. N. BANERJI: *Studies on Azo-aldehydes.* UMAPRASANNA BASU: *On Ketimine-enamine Compounds.* PRIYADARANJAN RAY AND JAGANNATH GUPTA: *Dimercaptothiobiazole as an Analytical Reagent.* C. NARAYANAN NAIR AND D. H. PEACOCK: *The Alkylation of Acetoacetic Ester by Toluenesulphonic Esters.* M.R. ASWATHANARAYANA RAO AND BASRUR SANJIVA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part I—Chemical Activity of Residual Water in Activated Silica Gel.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part II—Adsorptive Properties of Silica Gel containing Residual Hydrogen Chloride.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part III.—Volume changes produced on displacement of adsorbed liquids in Silica Gel by water.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part IV—Liberation of Air from Silica Gel Capillaries during Adsorption of Liquid.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part V—Specific Gravity of Silica Gel under Various Liquids.* PHULDEO SAHAY VARMA AND K. S. VENKAT RAMAN: *Halogenation. Part X—Iodination of Xylenes and Monoiodoxylenes.* M. R. ASWATHANARAYANA RAO: *Selective Adsorption and its Significance. Part I. Nature of Selective Adsorption.*

The Indian Botanical Society:

March 1935. DASTUR, R. H.: *Light and Fundamental Life Processes of Plants.* I. BANERJEE, SACHINDRANATH: *Telephoraceæ of Bengal.* BRIJ MOHAN JOHRI: *Studies in the Family Alismaceæ—I.* Limnophyton obtusifolium, Miq. RAU, N. S.: *A Further Note on the Iron Hæmatoxylin Technique,* 67. VASUDEVA, R. SAHAI: *Effect of One Organism on the Parasitic Activity of Another.*

Industrial Outlook.

The Industrial Manufacture of Absolute Alcohol—II.

By Jean Caupin.

IN a previous article[1] an account was given of the azeotropic process employed for the dehydration of aqueous alcohol. This process, as employed for the first time in France in 1923, consisted in sending alcohol of about 95 per cent. strength obtained by the ordinary process into a second independent apparatus, wherein, by employing benzene as entraining liquid, absolute alcohol of 99·8—99·9 per cent. strength was obtained.

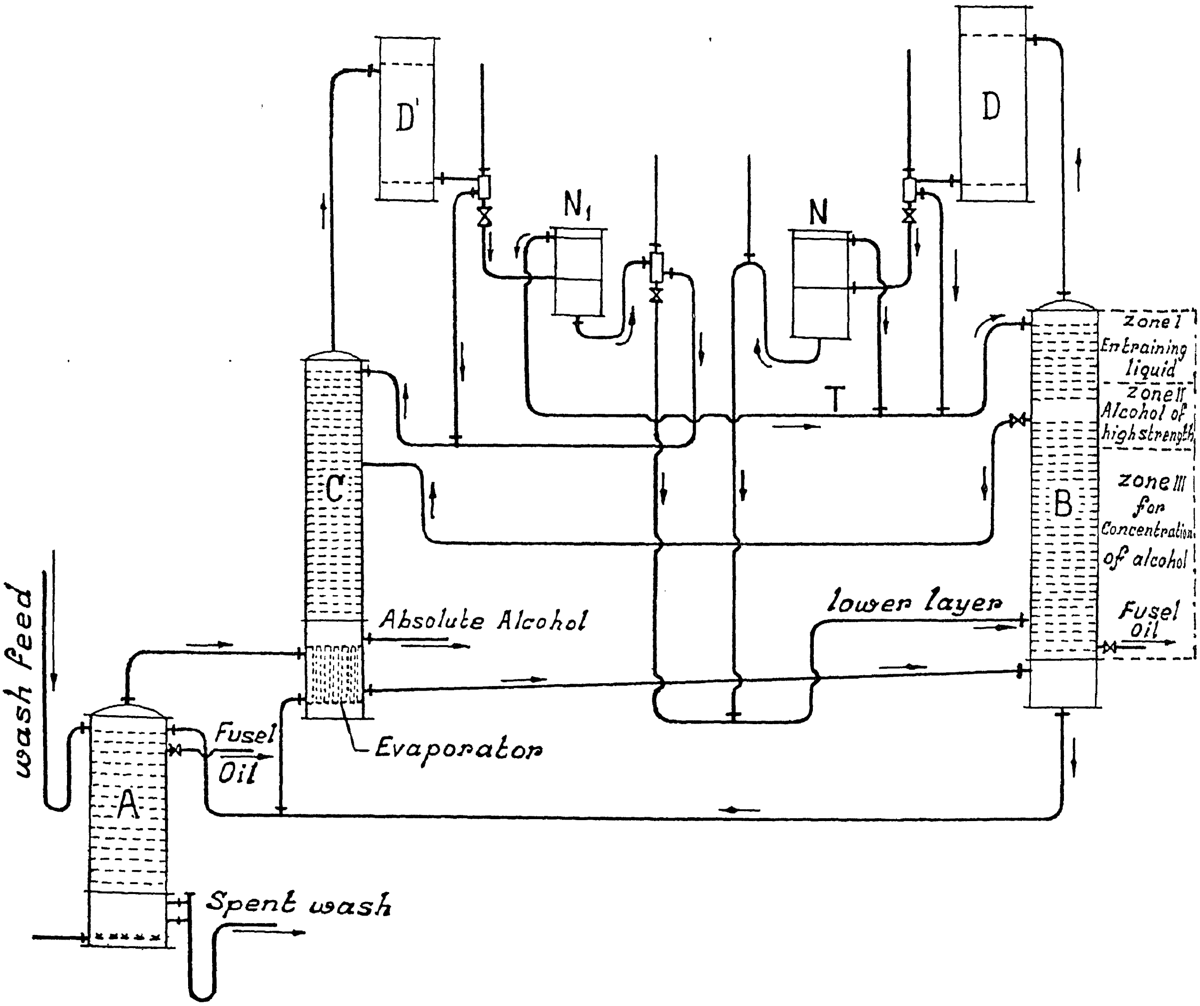
Recently, however, the researches of Guinot, the inventor, have rendered possible the manufacture of absolute alcohol from weak fermented liquors in a single operation instead of in two stages as was carried out in former years. At first sight, the above improvement appears to be impossible of attainment owing to the fact that, whereas in the ordinary process of rectification of alcohol, the concentrated alcohol is drawn off from the top of the column and water collects at the bottom, the reverse is true of the azeotropic process, *viz.*, the last traces of water present in the alcohol are carried to the top of the column and absolute alcohol collects at the base. This incompatibility is, nevertheless, easily resolved in practice, because the alcohol of high strength which collects in the upper plates of the concentrating column of the rectifier serves as an effective barrier owing to its ebullition point, which permits the addition of supplementary plates where the entraining liquid can work without difficulty for removing the last traces of water.

It will now be easy to examine and appreciate the scheme shown in the sketch of the equipment employed in industrial practice.

The fermented wash enters the column A and descends from plate to plate getting gradually exhausted at such a rate that the larger part of the water collects at the base. The alcoholic vapours heat up the column C and then undergo concentration in the column B. In the upper part of column B where the entraining liquid is introduced, the vapours present are similar in composition to that of the ternary mixture of water, alcohol and entraining liquid. The vapours are condensed in D and the liquid produced enters the decanter N where it separates into two layers. The upper layer which is a mixture of practically anhydrous alcohol and the entraining liquid returns continually to the top of the column.

Between the zone containing a high proportion of entraining liquid and the zone in which concentration of alcohol is effected,

[1] *Curr. Sci.*, 1935, 3, 385.



there is found a range of 4–5 plates containing alcohol of high strength (98·5–99 per cent.) mixed with a little of the entraining liquid. A suitable quantity of mixture is sent into the column C which is heated at the surface, and in which by continuous distillation it is possible to drive out completely the small quantities of water and entraining liquid present.

The absolute alcohol is drawn off at the base of column C, which is kept heated by the vapours arriving from column A. The quantity of heat furnished during the exhaustion of the weak alcoholic liquors is found to be sufficient to effect the concentration. The remarkable advantages of the method outlined above consists in (1) absolute alcohol can be manufactured in a single unit and at the same price as rectified alcohol, and (2) dehydration is easily effected with 4 per cent. of head products as against 10 to 15 per cent. in the ordinary rectification.

Further, the recuperation by an easy method of the vapours of the entraining liquid and alcohol permits keeping the loss of benzene below 0·04 per cent. This last improvement is of great importance for the development of the process, because the most important outlet for absolute alcohol is in its use as motor fuel with admixture of petrol.

It is essential, however, that in case of war and menace of blockade, the industry will not come to a standstill, if the special entraining liquids cannot be imported.

It is easy to demonstrate that with a minimum stock of benzene, a country like India can produce considerable quantities of absolute alcohol by the azeotropic method.

The total consumption of petrol in India

in 1931 was 72 million gallons. Admixture of 20 per cent. of alcohol with petrol will permit of the utilisation of about 14 million gallons of alcohol which could be produced from 7 million maunds or 250,000 tons of molasses.

This production of alcohol can be assured with 30 factories, each producing 2,000 gallons per day. The quantity of entraining liquid required for the starting of all these 30 factories will be roughly 6,000 gallons. The loss of entraining liquid will not exceed one gallon per working day for each distillery and the annual loss during the production of the total requirements of alcohol will only be 6,000 gallons of entraining liquid.

This quantity is not sufficient for the establishment even of a small factory for the production of the entraining liquid in India because a small stock will satisfy the requirements of many years. The above explanation will, therefore, eliminate the adverse criticisms regarding the azeotropic method.

We give below the cost of production of rectified alcohol, absolute alcohol by the First Technique (transformation of 96 per cent. into 99·8 per cent.), and absolute alcohol by the Fourth Technique obtained directly from fermented wash.

Approximate cost of production per gallon of (1) *Rectified Spirit,* (2) *Absolute alcohol by the First Technique, and* (3) *Absolute alcohol by the Fourth Technique.*[2]

Basis of Calculation :—

We will take for our basis of calculation the following, which are actually those that prevail in India:

Crushing capacity of the Sugar Factory: 400 to 600 tons.

Capacity of the Distillery: 750 maunds of molasses, *i.e.*, about 1,500 gallons (minimum) of alcohol every 24 hours, 200 working days, making an annual production of 300,000 gallons.

Price of molasses Re. 0–4–0 per Bengal maund.

Fuel: wood at Rs. 7 a ton.

1 lb. of wood gives 2 lbs. 8 oz. of steam, *i.e.*, price per lb. of steam is Re. 0–0–0·24.

We shall assume that the steam will be supplied by the boilers and the water by the pumps of the Sugar Factory.

(1) *Cost of obtaining a gallon of Rectified Spirit* :—

	Rs.	A.	P.
1. Building and Plant: about Rs. 187,500, to be redeemed in 10 years, *i.e.*, per gallon..	0	1	0
2. A maund of molasses ought to give two gallons of alcohol..	0	2	0
3. Consumption of steam; starting from fermented wash to obtain rectified alcohol: 38 lbs. at Re. 0–0–0.24 per lb., *i.e.*,..	0	0	9.12
4. Chemical products	0	0	0.73
5. Labour and staff: 9 men and 3 Indian chemists	0	0	3
6. Overhead expenses (Insurance, fire, interests, upkeep, office expenses)	0	0	4
Total expenses per gallon of rectified alcohol	0	4	4.85

The cost per gallon is about four annas six pies.

(2) *Cost of obtaining a gallon of Absolute Alcohol by the First Technique* :—

1. Cost of rectified alcohol ..	0	4	6
2. Consumption of steam, starting from rectified alcohol to obtain absolute alcohol: 13 lbs. of steam at Re. 0–0–0.24 per lb.	0	0	3.12
3. Loss of alcohol, *i.e.*, the difference between the quantity of alcohol that enters and that which comes out of the dehydration apparatus: 0.15 per cent. at Re. 0–4–6 a gallon	0	0	0.08
4. Loss of carrying liquid (Benzol): 0.01 per cent. at Rs. 3–7–0 per gallon	0	0	0.28
5. Plant: about Rs. 50,000 to be redeemed in ten years ..	0	0	3.20
6. Staff: 2 men	0	0	0.20
7. Royalties, about	0	0	5.50
Total price per gal.	0	5	6.38

The cost per gallon is about five annas six pies.

(3) *Cost of obtaining a gallon of Absolute Alcohol by the Fourth Technique* :—

Same consumption of steam as for rectified alcohol.

No loss of alcohol.

Same staff.

As a result of which the cost price is the same as that for rectified alcohol.

Four annas six pies.

Remarks :—

From the commercial point of view, the costs given above are perhaps excessive, because they are based on consumption of expensive fuel and also that all the molasses produced in a sugar factory can be sold at four annas per maund,

[2] The writer has, from actual experience in India, confirmed these figures.

In a succeeding article, it is proposed to discuss the very important question of alcohol as a fuel for power-raising purposes, and also to indicate the possibilities shown by the starting of the Distillery of the Mysore Sugar Factory, Mandya, the entire plant for which was furnished by *Ateliers Pingris et Mollet-Fontaine Reunis, Lille, France.*

Reviews.

HAND- UND JAHRBUCH DER CHEMISCHEN PHYSIK. Edited by A. Eucken and K. L. Wolf. Volume 9, Part 2. (Molekul- und Kristallgitterspektren. Akademische Verlagsgesselschaft M.B.H., Leipzig, 1934.)

This volume contains authoritative articles by Reinkober, Teller, Mecke and Finklenburg on the experimental methods of infrared spectroscopy, the theory of molecular and lattice spectra in the long wave region, the band spectra of diatomic molecules and finally the structure of some special molecules based on their spectra. In the article on the infra-red spectroscopy, Reinkober has given an account of the various sources of radiation, the different instruments for receiving the radiation, the experimental methods of the analysis of the radiation and the determination of wave-lengths in it. This account of the experimental methods seems to be fairly comprehensive. The theory of molecular spectra in the long wave region has been dealt with by Teller in a very clear fashion. He has presented the theory of the vibration, the rotation and their interaction in the case of a diatomic molecule both on the classical and quantum-mechanical standpoints and also their activity in the infra-red and Raman spectra. Next, the normal vibrations of a polyatomic molecule, their symmetry properties and the selection rules governing their activity in the infra-red and Raman spectra have been dealt with. The rotation of a polyatomic molecule, the interaction of rotation and vibration and the isotope effect in vibration have been also treated. In the next article on the lattice spectra, he deals with the total reflection in the vicinity of a region of absorption and the vibrations of a linear lattice. He has pointed out the relations that exist between the spectra and other properties of crystals. The article on band spectra by Finklenburg and Mecke contains the methods of the photography and the analysis of band spectra, the application of wave-mechanics to a model with two centres, the treatment of the nuclear motion and rotation and the interaction of the rotation and electron motion in the model. The symmetry properties of molecules and their band structures have also been dealt with. The experimental results of band spectra of diatomic molecules have been collected and presented by Mecke in the next article. The chapter on the structure of polyatomic molecules on the basis of their spectra has been written by Mecke. The expressions for the frequencies of the XY_4 type given on page 353 requires modifications. In the case of acetylene, there seems to be no clear reason as to why $\delta\,(s)$ (inactive) should be 600 cm.$^{-1}$ except that it should interpret the 1329 cm.$^{-1}$ band in combination with $\delta\,(a)$ which is 729 cm.$^{-1}$ One may note that the band in question can be interpreted as $\nu_1\,(a)-\nu_0\,(s)$, and the 5250 cm.$^{-1}$ band as $\nu_1\,(a)+\nu_0\,(s)$, which is in conformity with Dennison's selection rules. A theoretical calculation of the frequencies based on the valence force system shows that $\delta\,(s) > \delta\,(a)$, thus throwing doubt on the assumption that $\delta\,(s)$ is 600 cm.$^{-1}$ The split of $\nu\,(a)$ in CBr_4 observed by Langseth may be explained as due to the resonance $\nu(a) \sim 2\nu(s) + \delta(s)$.

The volume contains clear articles by authoritative persons in the subjects dealt with.

N. S. N.

* * *

PHOTO-ELECTRIC AND SELENIUM CELLS, THEIR OPERATION, CONSTRUCTION AND USES. By T. J. Fielding. (Chapman & Hall Ltd., London.) Pp. 140. Price 6s.

Next to the thermionic valve the photo-electric cell can claim to be one of the most outstanding inventions of the present century and has as universal an application as the former. The advent of the talking pictures and the more recent developments in television has created in the general public a keen desire for knowledge of this interesting device. The host of books that have appeared from time to time have failed to meet this demand since they are very often either too technical or at least demand a fairly good scientific background.

This little book although very limited in its purpose does justice to the intentions of its author, namely providing a brief

introduction to the use of light-sensitive devices in general. The author gives a lucid description of photo-electric and selenium cells and their construction, providing an average practical-minded person, data enough to construct some of the simpler type of selenium cells. The chapter dealing with talking pictures, television and its application to general industry will familiarise the reader with the principles and uses of the photo-cell. On the whole a very useful book for a beginner.

C. C.

* * *

A SYMPOSIUM ON ILLUMINATION. By C. J. Webber Grieveson. (Chapman & Hall Ltd., London.) Pp. 229. Price 13*s*. 6*d*.

The book is a collection of lectures, each probably lasting for an hour or so, delivered by eminent men counted as authorities in the various branches of Illumination, as acknowledged by the Editor himself in his Note. It is certainly the best collection I have known. All that could be squeezed within the limited space allotted to the authors has been presented and made intelligible. The book can be recommended to every one who wishes to have a general idea of illumination for various purposes, which no engineer can afford to overlook in the modern rush for securing the best illumination with minimum expenditure.

M. HAYATH.

* * *

SHORT COURSES IN CHEMICAL THEORY. By E. P. Wilson. (T. M. Dent & Sons, Ltd., London, 1935.) Pp. viii+247. Price 3*s*.

There are very few publications which can be grouped along with the book under review in view of its somewhat novel treatment. The book is a collection of lecture-notes on chemical theory, highly useful to teachers and students alike. There are 22 chapters, dealing with the various aspects of chemical theory as taught in the Colleges to senior students. The notes serve to concentrate the attention on the crucial points of the subject. The book is a very useful addition to every College Library and is the outcome of the long experience of a *teacher*. Provision is made for the addition of examples, notes and diagrams in the book by the insertion of blank pages and the student is thus enabled to add to the information already contained in the book.

The Book is not, however, free from errors and from the point of view of the student this is to be regretted. To cite a few random instances: on page 87 under enzyme actions *emulsin* is printed as *emulsion;* one does not speak of *badly* ionised solutions (pages 143 and 144) but of *weakly* ionised solutions; sentences which have no relation to the context are often used as for instance, on page 171, under Osmotic pressure of colloids, it is difficult to understand the bearing of the sentence *Parchment paper (a colloid) gives best results;* on page 172 under electrical properties (5) the sign, =, used against KCl, $MgCl_2$ and $AlCl_3$ is incorrect, as the author intends to convey that 49·5 parts of KCl, 0·717 parts of $MgCl_2$ and 0·093 parts of $AlCl_3$ possess equal capacities for bringing about coagulation; on page 216, in providing examples for ionic dissociation in solutions we find that the dissociation of NaCl is represented as $NaCl \rightarrow Na + Cl'$, it should read $NaCl \rightarrow Na^{\cdot} + Cl'$. We should also like to see a glossary attached as it is somewhat difficult to understand the large number of abbreviations so often used throughout the text. In spite of these obvious errors, the book should prove highly useful to college students preparing for examinations.

* * *

STUDIES ON INDIAN ITONIDIDÆ (*Cecidomyidæ diptera*). By M. S. Mani. (Records of the Indian Museum, Calcutta, 1934.) Vol. 36, Part IV. Pp. 371–451. (28 Figures and 1 Plate.)

The study of galls interests the zoologist, as most of them are caused by the agency of insects and mites; the botanist, since the host plants often show a specific behaviour towards the causal agencies; and lastly, the plant pathologist, whose labours contribute towards a comparative pathology of tumours and cancers. In Germany, Hedicke, the Berlin Zoologist, Ross, the Munich Botanist, and Küster, the Plant-Pathologist at Giessen, have each shown how galls are worthy of attention. India, with its abundant supply of material for study, offers a virgin ground for the study of galls from all these three standpoints. Mani's monographic study of *cecidomyid* gall producers may be taken as a precursor of many more communications in this field. His study, under review, is not "Notes" or a sketchy study of the material he already found in the Calcutta Museum; he has personally collected most of the specimens described, even adding notes on the life-histories of the insects wherever opportunities permitted him to gather such information. This partly explains why most

of the insects named are derived from South India. We hope, inspired by Mani's example, others would also extend our knowledge of Indian gall-producing insects. Most Indian entomologists have confined their enthusiasm to the field for, when the question of naming new species had to be faced, they preferred acting as exporters for specialists outside to sift through the mass of crude material and thus enjoy the prerogative of creating names new to science giving their own study the stamp of a finished article. Mani has taken on himself such a responsibility and has given to the world several new genera, not to say of new species. A complete bibliography is given and grateful acknowledgment is made to several authorities. While his claim to originality is self-evident, it is equally apparent that a vein of modesty impregnates his style which makes his publication the more agreeable reading. The monograph ends with a single plate, containing photographic reproduction of five kinds of galls whose causal agents have been named by Mani; we only wish there were more of them. His pen and ink illustrations might have been better, particularly Fig. 19 on page 426, hardly does credit to the otherwise excellent study of Indian *Cecidomyids*. S. M.

* * *

A REPORT ON THE PROSPECTS OF PAPER MANUFACTURE IN HYDERABAD STATE. By Md. Moula Baksh, M.A. (Oxon.), F.L.S., and Khaja Nazamuddin, B.Sc., Tech. A.M.C.T. (Manch.) Pp. 71. (H. E. H. the Nizam's Government: Commerce and Industries Department Bulletin No. 4, New Series.) Price Rs. 2-8-0.

This report discusses the advisability and practical possibilities of establishing a pulp and paper mill in the Adilabad District making use of bamboo (*Dendrocalamus strictus*) available in the area as the source of fibre. It has been shown that good paper can be manufactured from these bamboos as is evident from the samples contained in the report.

The total production of paper in India at present is only 45,000 tons a year, while the import for the same period averages about 100,000 tons. All the relevant facts including cost of the raw materials have been discussed in detail in the report with a view to encourage some capitalist to start a factory and we hope that the expectations of H.E.H.'s Government will be realised in the near future. K. A. N. R.

* * *

Creatine et Creatinine par Fernand Kayser (Actualites Scientifiques et Industrielles No. 178. Hermann et Cie, Paris).—This little volume is divided into two parts. Part I is devoted to a description of the chemistry of creatinic substances and Part II to the biophysical studies. A clear and critical review of the existing methods of preparation and estimation, including some of the author's investigations, is given. There is an excellent bibliography in the end. The author complains of the insufficiency of the work done on these substances in France. C. S.

* * *

Metabolismes Des Corps Creatiniques par Fernand Kayser (Actualites Scientifiques et Industrielles No. 179. Hermann et Cie, Paris).—As in the previous number, this book also contains two parts. Part I treats of the metabolism of creatin and creatinin discussing in some detail the occurrence of creatin and creatinin in urine under physiological, pathological and experimental conditions. Part II deals with the pathological conditions only: the variation of creatin and creatinin in the affectations of the kidneys, muscles, the thyroid gland and in certain diseases like diabetes, gout, arthrites, etc. The prognostic value of determining these creatinic substances in the body fluids is indicated. Only eight pages are devoted for the pathological study, perhaps to keep in conformity with the shortness of these monographs. A good bibliography is appended. C. S.

Forthcoming Events.

The Geological, Mining and Metallurgical Society of India:—
Annual General Meeting, Monday, 2nd September 1935, 5-30 p.m.

1327-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

Current Science

Vol. IV] SEPTEMBER 1935 [No. 3

CONTENTS.

The Indian Institute of Science.

IN view of the impending appointment of the second Quinquennial Reviewing Committee, a brief survey of the development and activities of the Indian Institute of Science, Bangalore, during its life of twenty-five years, may assist in creating sympathetic and enlightened public opinion. This will provide a favourable background, rendering the task of the Committee perhaps less tedious and more congenial; it may even be found indispensable to the formulation of a definite policy for promoting schemes of reform and expansion, such as the Committee may deem desirable to recommend on the conclusion of their labours. The first Quinquennial Reviewing Committee have, in more than one section of their report, drawn attention to the prevailing public ignorance of the work and resources of the Institute, and have also adversely commented on the general misconception among members of the Court regarding the economic activities of the different departments. Such ignorance and misunderstanding, if allowed to persist, would favour the growth of public prejudice affecting the character and fair reputation of the Institute, although there is ample testimony of honourable work steadily pursued in a spirit of disinterested service to the country. It is true that the Pope Committee reported in 1921 abundant evidence that there existed in many quarters "a strong feeling of disappointment and dissatisfaction" with the then existing condition of the Institute; and if such a feeling still prevails in the public mind, it must be almost entirely due to general ignorance of the steps that have since been taken to remove partially or entirely the causes which led the Committee to record the adverse comment. If, however, there is still a source of dissatisfaction either within the precincts of the Institute or outside, we think it must arise from defects inherent in its organisaton as well as from lack of a sound and definite policy, understood by all concerned, in regard to both the academic and the administrative spheres of this great foundation. In a short contribution on the Indian Institute of Science published in this *Journal* (October 1932), Alchymist observes that "with this provision (resources becoming available) the future, to which we now look for progress and expansion at least comparable with those of the last fifteen years, is hopeful". Manifestly the writer of the article is favourably

impressed by the advances made by the Institute during this period in the different branches of its activity. Sometime ago it was pointed out in an article in *Nature* (April 29, 1933) that "even if such an Institute were established in Great Britain, where the distances are not of the same continental order, it may be doubted if it would attract as many science graduates taking courses of advanced study and training for research as are now at Bangalore". This is a disinterested testimony to the increasing popularity and sound reputation of the Institute.

We have perused practically all the annual reports of the Council and have referred to almost all the volumes of the *Journal* of the Institute. They are probably the only authoritative documents which give information regarding the development of this institution, and when read in conjunction with the two Committee Reports reflecting the views and opinions of independent experts, we have all the materials necessary for forming a fairly correct judgment on the fundamental question of how far and in what manner the achievements of the Institute have fulfilled the aims and intentions of its founder, and also the intelligent expectations of the cultured public who look to the Institute for a lead in the economic and industrial life of the country. Judged by the ordinary academic standard, the Institute has a blameless record.

After briefly reviewing the administrative and financial matters of each year, Council Reports chronicle the departmental occupations of the Institute in a greatly abridged form, and their results are catalogued in the Appendices. To obtain a comprehensive and analytical view of the activities of the Institute, we propose to investigate the records for twenty years (1914–34), a period covered by the Pope and Sewell Committee Reports. During this period three departments, *viz.*, General and Organic Chemistry, Electrical Technology and Biochemistry,—were operating—and in 1934 the Department of Physics was instituted. The total volume of laboratory investigations undertaken in all these departments is reflected in the number of preliminary reports communicated to the Indian Science Congress, and in the number of papers published in the *Journal* of the Institute and in foreign scientific periodicals. In estimating these results, account must be taken also of consultative work in which the members of the staff and research scholars were engaged.

Our analysis has yieldeu,aper in Indi
The Institute began to year, while
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students who qualified for certifi
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income amounted roughly to Rs 1
and the expenditure to Rs. 10
nearly 50 per cent. of which was u
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the opinions expressed by the
Sewell Committees, the scientific
of the laboratories for every desc
research in the relevant subjects
unrivalled in India.

The evolutionary history of the
may conveniently be divided i
natural stages which we may ch

as the periods of exploration, consolidation and action. Between the years 1911 and 1921, the Institute was practically engaged in equipping itself for the duties of a " new Institution entirely novel to the country and therefore without a fund of experience on which to draw "—a factor which must impose a serious handicap on its emergence at once as a foundation rich in traditions and in spectacular achievements. The Council was engaged during these ten years in a very full and thorough discussion of the numerous administrative and academic problems arising from the resignation of Dr. M. W. Travers and of Professor Rudolf at the end of the session 1913–14 ; the schemes prepared by the special Committee of the Council involving considerable expenditure for equipping the new department of Applied Chemistry and for extending other existing laboratories ; the refusal of the Government of India to grant extra financial assistance owing to the War and the failure of the efforts of the Council to secure a Director who could also assume the duties of a professor of applied chemistry. In 1915, when the affairs of the Institute were passing through a critical phase, the Indian Industrial Commission was appointed, and when Sir Thomas Holland and Sir Dorabji Tata met Sir Alfred Bourne in the year 1916, a memorandum was presented to the Commission suggesting that the Institute should form a nucleus for the development on a large scale of an Indian Institute of Chemistry. This proposal was not in consonance with the resolution of the Government of India (May 1909) that " they were of opinion that the idea of combining in one Institution and entrusting to a single staff of professors, both the teaching of science and the experimental development of new industries, was open to the obvious criticism that these two objects were in no way connected." The Holland Commission accepted the Memorandum of the Council because they discovered that the Institute had departed from the resolution of the Government of India and from the aims and objects of the founder of the Institute, and a significant paragraph they wrote that, riginally projected by the late Mr. J. N. ata with the object of encouraging postraduate study and training for research a pure physical science, the Institute has, n the course of a comparatively short career, developed a distinct tendency towards the study of problems which are likely to lead to results of immediate economic value, rather than towards the pursuit of investigations of purely scientific interest. As a result of this bias towards chemical industry, the Institute was invited to cooperate with the Indian Munitions Board in the work which that Board had undertaken towards utilising local resources for war, and such assistance necessarily implied the temporary suspension of normal work in the departments. This co-operation finally led the Council to the conviction that " the Institute should concentrate effort on industrial chemistry and endeavour to secure further funds towards that end " and owing largely to the influence of this conviction great progress was made in the years 1916-18 towards associating the work of the Institute with that of the industrial departments of Government. The progress made in the applied branches of chemistry is reported in detail in a monograph issued by the Institute on the ceremonial occasion of unveiling the statue of Mr. J. N. Tata, and led the Council and Government to reconsider the future policy and lines of development. The Pope Committee was appointed in 1921 and their report introduced the second phase in the life-history of the Institute which we call the period of consolidation.

Dr. M. O. Forster (now Sir Martin Forster) was appointed Director of the Institute in 1922 soon after the publication of the Pope Committee Report. In less than three years of his assumption of duties, three professors retired on reaching the age-limit ; Dr. Alfred Hay in December 1922, Dr. Gilbert J. Fowler in 1924 and Dr. J. J. Sudborough in June 1925, the vacancies being filled by Mr. J. K. Catterson-Smith, Dr. R. V. Norris and Dr. J. L. Simonsen, respectively. Dr. Forster's time and energies were devoted to examining the administrative and departmental problems adumbrated by the Pope Committee and to exploring the means of implementing, in so far as might be possible, their recommendations. In the department of Biochemistry, Dr. Fowler had established a distinguished school of research in several applied branches, and Dr. Norris proceeded to found new ones. Relieved from the influence exerted by war-conditions, practically all the departments resumed the pursuit of investigations in pure science, maintaining, however, such *liaison* with industrial problems as opportunity offered. Dr. Forster's administration will be remembered chiefly as a period of consolidation of the

moral and material resources of the Institute, in accordance with the proposal of expansion outlined in the Pope Committee report. It was also the period which witnessed the rapid evolution of departmental activities which created a suitable atmosphere for the next phase of development. Before Dr. Forster relinquished his office in March 1933, the Sewell Committee had reported.

Sir Venkata Raman, the new Director, assumed charge of his duties almost immediately. It must be remembered that Sir Venkata Raman was a member of the Pope Committee and had sat in the Council of the Institute for over seven years. In this respect the new Director had an advantage over his predecessors, *viz.*, that he entered upon his duties with a complete knowledge of the work of the Institute such as few could claim to possess. But they were not confronted with the difficulties which Sir Venkata Raman had to encounter. He had soon to face a deficit budget. The Physics Department had to be constructed and equipped. The proposals of the Sewell Committee had to be considered. In the meantime Dr. H. E. Watson and Professor F. N. Mowdawalla proceeded to other appointments. Dr. Watson, who was the senior member of the Institute Staff, had by his energy and character elevated the Department of General Chemistry to an honourable position, and some of his researches had led to the establishment of industries. His departure from the Institute is undoubtedly a great loss. Professor Mowdawalla was a former scholar of the Institute where he had conducted several investigations in the Department of Electrical Technology, and his place is to be filled by Mr. Kenneth Aston. In the Council Report for 1934–35 the Department of Physics organised by Sir Venkata Raman is shown as having produced 39 papers, General Chemistry 9, Organic Chemistry 14, Biochemistry 49 and Electrical Technology 15, in other words the total output of research during this one year was 127 papers. We had almost a paper for every three days emanating from the Institute. This is research in [illegible] action.

The Pope Committee deplored that "the Institute has lost in efficiency by reason of the fact that its policy and lines of development have never been defined with sufficient precision" and an examination of the Council Reports since 1922 does not disclose any comprehensive and clearly defined policy directed to the promotion of the welfare and progress of the Institute and of its relation to the economic and industrial life of the country. Perhaps the most important question which the Institute will be called upon to settle is whether it will continue to provide preliminary training in scientific methods and knowledge in its departments and also to hold certificate and diploma courses in Electrical Technology, particularly in view of the fact that almost all the Indian universities have instituted research departments both in theoretical and applied branches of science, in which work of a very high order is conducted, manifest from the number of papers published in India and abroad. In most of the universities, post-graduate work involves a considerable amount of training in research methods, and the M.Sc. Degree is awarded on the submission of a thesis on an original problem. In view of the rapid strides that universities and government research departments are making in the field of research, the Indian Institute of Science has to shape its academic policy to suit the altered conditions in the country.

The essence of this policy, as we conceive it, is that the Institute must find facts, while the public and government must find out how to use them. One of the main articles of such a policy would be to launch a campaign to convince the new legislatures and other bodies who control finance, that research is wealth, and that the greatest tributaries to it are chemistry and physics, through their contributions to agriculture, medicine, metallurgy and the entire range of manufacturing occupations. The second factor in this policy is to insist upon public recognition of the fact that the prosperity of a country in a competitive civilisation depends not so much upon the control of natural resources as upon the control of scientific processes. The work of the Institute in the field of fundamental research and industrial research should no longer be permitted to remain an inscrutable mystery to statesmen and administrators whose position in public life and whose influence in the legislative councils would be a material agent in establishing new research laboratories. The Institute is essentially a single organism, whose health and functional efficiency depend upon the harmonious co-operation of its different members, and in order to secure such co-ordinated effort and infuse a sense of collective responsibility,

the different departments must develop mutual interests and remove the spirit of exclusiveness. This is best done by the establishment of borderland branches of science, which would bind the several units into a single corporate body with common aims and purpose.

The question of the status of the Institute is discussed by the Sewell Committee. They have stated "that the Institute ought always to be in a position to provide such opportunities as cannot be obtained anywhere else in India; that it should do what no other institution can do; that it should maintain a position of pre-eminence; that it should acquire even a world reputation and that it should become a place of reference." The path to attaining this ideal is also indicated in the report, *viz.*, the personnel of the directorate, professoriate and staff, to which we would add finance. These admirable sentiments, however, are not in consonance with the theory elaborated by the Committee regarding the sources of revenue to be explored by the Institute. It seems to us that the preservation of the All-India or international character of the Institute depends upon the regional origin of its finances, its staff and students; and any suggestion of contribution by the provinces in proportion to the benefits received by their scholars must militate against the All-Indian status of the institution. On the other hand, contributions based on the financial capacity of each province irrespective of other considerations will invest the policy and outlook of the Institute with a national character. Each British Province and each major Indian State might endow a chair and support the laboratory attached. The late Mr. J. N. Tata never contemplated personal or communal benefit from the Institute which his munificence founded. The Institute is the cultural rallying point of the Indian Nation, and its structure is an indivisible unit. If the provinces, the Indian States and the industrial magnates consider it their patriotic duty, rendered in a spirit of pure altruism, to create and support associate professorships, readerships and lecturerships in appropriate branches of science, then it may be possible to release the funds of the Institute more freely for developing its international reputation, by inviting scientists of outstanding eminence such as the Sewell Committee contemplate, to associate themselves with the life and work of the institution. If it were only possible to induce such men to come to India —and it may not be difficult provided we have the resources—the universities, the government scientific departments and the industries would be glad to secure their co-operation and only then would the Institute be in "a position to do what no other Institution could do". It is gratifying that, with the limited funds at his disposal, Sir Venkata Raman has already taken the first step in this direction by inducing the Council to invite Professor G. Hevesy and Dr. Max Born to stimulate the work of the Institute; further development of this great institution must depend upon the financial support of provincial governments and of the Indian States.

Academy of the Natural Sciences of Philadelphia.

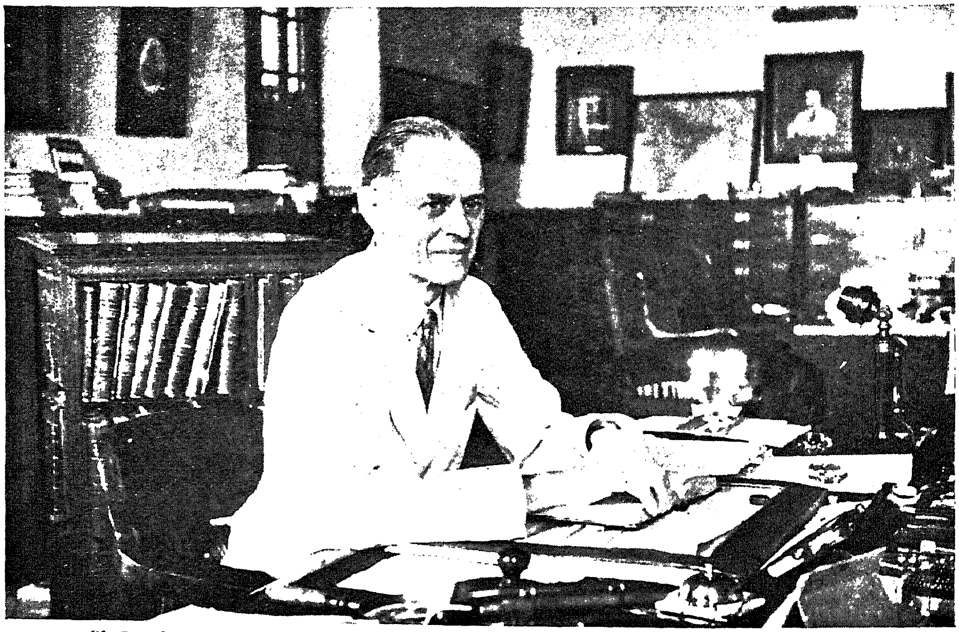
MUSEUM workers all over the world are familiar with the high standard of publications issued by the Academy of Natural Sciences of Philadelphia, which is maintained wholly by private endowments and contributions from members and friends. This Academy was founded in 1812 and has done great service in stimulating research in natural sciences in almost a century and a quarter of its existence. The 86th volume of its *Proceedings* for 1934 has been recently issued. It contains 17 contributions from well-known workers. Of these 15 are on zoological subjects dealing with Mammals, Birds, Reptiles, Amphibians, Fishes and Molluscs, and two small ones on botanical subjects. The interesting feature of this volume is that it contains contributions about the Zoological Results of the Third De Schauensee Siamese Expedition, of the Matto Grosso Expedition to Brazil in 1931, and Dolan West China Expedition of 1931. These expeditions account for 7 papers out of 15. Another remarkable feature of the series is that separates of the contributions presented in its *Proceedings* can be purchased at a small cost. There is a good index to the genera and species described and referred to in the volume. The full volume comprises 589 pages and 23 plates, mostly of molluscs. It is further illustrated with numerous drawings in the text. The price of the full volume is \$5·00 to subscribers and \$6·25 to others.

Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., A.R.S.M., F.R.S., F.G.S., F.A.S.B., M.Inst.M.M.

AFTER thirty-three years' distinguished service to India, Sir Lewis Fermor will be retiring this month from the Directorship of the Geological Survey of India, and India will be losing one of her most distinguished scientists. We take this opportunity of paying our tribute to one who has laboured so well for the cause of Science in India.

Trained as a geologist at the Royal School of Mines under Prof. J. W. Judd, with a strong interest in metallurgy, Sir Lewis Fermor was appointed to the Geological Survey of India in 1902, at the time that Sir Thomas Holland assumed the Directorship of the Survey. His promise of exceptional ability was recognised when he was promoted to the grade of Superintendent in 1910, at the early age of 30.

Sir Lewis Fermor's first introduction to Indian Geology was given to him by the late Mr. E. W. Vredenburg, whom he accompanied into the field in Central India. It was on this occasion that Sir Lewis first came into contact with manganese ore deposits in the field, and it was probably due to this that in the following year Sir Thomas Holland, thinking it advisable to examine scientifically what was then already a flourishing industry, deputed Sir Lewis Fermor to investigate the manganese ore



Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., A.R.S.M., F.R.S., F.G.S., F.A.S.B., M.Inst.M.M.

deposits of India. It is probable, however, that Sir Thomas Holland never visualised that this work would take six years to complete, and lead to the publication of a monumental memoir running to 1294 pages. In this great work, by which Sir Lewis is still best known outside India, manganese was treated from almost every point of view; and hidden away in this memoir there is a wealth of original observation, concerning not only manganese itself but also many related geological problems, which has frequently been overlooked. Of the many valuable results accruing from this work, one may specially be mentioned, since it proved to be of direct help to the mining companies which were engaged in winning the ore. This was the recognition that the folded sheets of manganese ore had generally a marked pitch, and that the direction of this pitch could be determined in a single exposure by observing the groovings developed on the bedding planes of the associated rocks. The recognition of this principle must have saved the companies many thousands of rupees, previously lost through

their inability to understand the probable underground course of the ore bodies.

The number of papers already published by Sir Lewis Fermor is well over 80. Of these one may be picked out as of particular scientific interest. As a result of studying the rocks of the Eastern Ghats, which are rich in garnet and of high density, it occurred to Sir Lewis to enquire into the reasons for rocks in certain areas being composed of minerals of high density, such as garnet, whereas elsewhere rocks of similar chemical composition are composed of minerals of lower density. This led him to suggest that below the plutonic zone of granites and gabbros there occurs an infra-plutonic shell of similar bulk composition but composed of denser minerals, of which the chief is garnet. This shell was regarded as being a cushion upon which the isostatic operations of the earth have their foundations ; for it would only require a release of pressure over any given portion of the infra-plutonic shell to allow the liquefaction of that portion of the shell under the high temperatures present. In this way he was able to offer an explanation of many geological problems, such as isostasy, magmatic differentiation, the origin of earthquakes, and even the constitution of meteorites. It is unfortunate that this work, published so long ago as 1914, has not been followed up in greater detail. At the moment it is being revived in connection with the origin of earthquakes, and one Japanese seismologist has recently supported the hypothesis, following up R. D. Oldham's suggestion that earthquakes are due to the sudden transformation of rocks of the infra-plutonic zone into less dense forms in the manner indicated above, a change, which, being endothermic, may take place with explosive rapidity.

In 1911 a detailed survey of the Archæan rocks of the Central Provinces was begun, and Sir Lewis Fermor was placed in charge of the party. He at once initiated the mapping of these very old rocks in a more detailed manner than had ever before been attempted. This work has continued intermittently since that date, but it is unfortunate that owing to official administrative duties Sir Lewis has not yet had an opportunity of publishing his own results. We may perhaps express the hope that in the quieter times ahead opportunity may be found for bringing this valuable work to fruition.

During the War Sir Lewis Fermor rendered valuable service on deputation to the Railway Board, during which time he investigated the Bokaro coalfield, and the Karanpura and Talchir coalfields, while he also went on deputation to the Indian Munitions Board. The value of this work received recognition at the hands of the Government of India when, in 1919, he was made an O.B.E. For his contributions to theoretical geology he was awarded in 1921 the Bigsby Medal of the Geological Society of London, while in 1934 he was elected a Fellow of the Royal Society.

During his long service in India, Sir Lewis Fermor has been President of the Mining and Geological Institute of India, President of the Geology Section of the Indian Science Congress, General President of the Indian Science Congress, and now, at the time of his retirement, he is President of the Asiatic Society of Bengal, and President of the National Institute of Sciences of India, the oldest and the youngest academies of scientific learning in India. To each of these Institutions he has delivered inspiring and original addresses, which have indicated the wide scope of his outlook.

Sir Lewis Fermor was made Director of the Geological Survey in 1932. During his tenure of the Directorship it has been a great disappointment to him that his Department, for adventitious reasons, suffered so severely during the retrenchment carried out by the Government of India in 1931-32. His untiring advocacy of the value of the Geological Survey to the prosperity of India has, however, resulted in the partial restoration of the cadre of his Department. In the Birthday Honours of this year the honour of Knighthood was conferred upon him for his long and distinguished services to India, a reward, however, which he himself likes to regard as a recognition by the Government of India of the value of his Department to this country.

Great as have been Sir Lewis Fermor's achievements in the development of India's mineral resources and in the domain of pure science, it is probable that many will regard his unremitting endeavours last year to unite scientists in India, when there appeared the possibility of an undignified rupture, as his most happy achievement. The tact and patience which he displayed as Chairman of the Indian Science Congress Academy Committee revealed to many a new aspect of his character, which finally resulted in the formation of the National Institute of Sciences of India, inaugurated on January

7th, 1935, by H. E. Sir John Anderson, the Governor of Bengal, with Sir Lewis Fermor as the first President.

In bidding farewell to Sir Lewis Fermor, it would be ungracious to omit a reference to Lady Fermor. During the three years that she has been by his side in India, she has, by her charm and understanding, endeared herself to all who have had the good fortune to come in contact with her, and especially to every member of Sir Lewis Fermor's own Department. We hope that the years that are ahead of them may be rich in achievement and filled with prosperity and happiness.

Industrial Intelligence and Research in India.

By N. Brodie,

Director, Industrial Intelligence and Research Bureau.

THIS article deals with the formation and activities of the organisation recently set up by the Government of India to deal with industrial intelligence and research. The importance of industrial research under present-day conditions is universally recognised and Government bodies of one sort or another exist in all the major industrial countries but industrial intelligence is not so much in the foreground and, by laying some stress on this, India strikes out a new line. Nevertheless, although not given the same emphasis in other countries, industrial intelligence is generally, perhaps always, an important accompaniment of industrial research and most industrial research organisations have some arrangement for intelligence work, frequently in the form of a special department dealing with this work.

In India Industries is a transferred subject and therefore, so far as British India is concerned, a matter for the Provincial Governments. Most Provincial and many State Governments have instituted Departments of Industries, generally under the charge of an officer designated the Director of Industries. Several Departments of Industries, both in the Provinces and in the States, maintain industrial laboratories in which research work is carried out. For some time past it has been generally felt that the activities of these different laboratories suffer from lack of co-ordination and at the Fifth Industries Conference, held in July 1933, this question was raised in a specific form and it was recommended that "some central co-ordinating authority should be set up for the collection and dissemination of industrial intelligence, co-ordination of research and the organisation of industrial exhibitions". This recommendation was accepted by the Government of India and it was decided that a body of this type should be formed and attached to the Indian Stores Department, a Department which has much contact with industrial matters in India. The Chief Controller of Stores, Sir James Pitkeathly, drew up a scheme which was placed before and accepted by the Sixth Industries Conference held in July 1934 and subsequently sanctioned by the Government of India. This scheme will be found described in detail in bulletin of Indian Industries and Labour No. 52 giving the proceedings of the Sixth Industries Conference.

In accordance with Sir James Pitkeathly's proposals the Government of India sanctioned, with effect from the beginning of the present financial year, the formation of what is known as the *Industrial Intelligence and Research Bureau.* The staff of the Bureau consists of a Director, an Assistant Director and the necessary technical and clerical assistants. It is attached to the headquarters of the Indian Stores Department and is therefore located at New Delhi and Simla. At the same time a Research Branch was formed at the Government Test House, a laboratory situated at Alipore (Calcutta), which is also under the control of the Indian Stores Department. The staff of the Research Branch consists of a Research Officer, an Assistant Research Officer, 8 Chemical and Physical Assistants and clerical and menial staff.

The programme of the Research Branch and all important matters of policy involving the Bureau are brought before the Advisory Council for Industrial Intelligence and Research. This Council consists of the Directors of Industries or corresponding officers of the Provincial Governments and of seven Indian States, representatives of different Central Government Departments, four non-official members nominated by the Government of India and non-official

members nominated by each of the Provincial Governments. The Chairman is the Joint Secretary to the Government of India, Department of Industries and Labour and the Director of the Bureau acts as the Secretary. By the inclusion among the members of the Advisory Council of a considerable non-official element, it is hoped that the Council will be able to obtain the assistance of Industrialists and business men and hence keep in touch with the practical problems of industry.

The Advisory Council held its first meeting in Simla on July 8th and 9th, 1935. As a first step towards the co-ordination of the research activities of the different Provincial and State laboratories it was decided to form a Committee to deal with research in two subjects with one or other of which, as it happens, every such laboratory has, to some extent at least, interested itself. These are: (1) fatty oils and soap, and (2) essential oils. A second Committee was appointed to consider the question of the allocation of prizes for papers for which purpose a sum of Rs. 10,000 a year has been set aside. The programme of research for the Government Test House was considered in detail and various researches were agreed to. As a step towards forming a judgment of the problems of the glass industry in India it was recommended that the Bureau should undertake a survey of the glass factories in India and publish a review of the whole position. The important question of industrial standardisation was considered and it was recommended that specifications used by the local governments and the Railway and Indian Stores Department should be sent to the Bureau for examination. The object of this is to ensure that specifications are so framed as not to exclude materials made in India.

It will be seen that the organisation for industrial intelligence and research consists of three distinct but closely linked parts, *viz.*, the Advisory Council, the Bureau and the Research Branch of the Government Test House. The Advisory Council deals with broad questions of policy in all matters affecting the organisation as a whole. The present intention is that it should meet once a year and it has been proposed that it should meet at different important centres in rotation. Matters sufficiently important to be brought before the Council which cannot await the annual meeting are dealt with by correspondence. The Bureau acts as the secretarial body of the Advisory Council and implements its recommendations. On the research side it is responsible for drawing up detailed schemes of the projects accepted by the Council. On the intelligence side it deals with requests for industrial information forwarded by Directors of Industries. This is the normal channel through which enquiries are received. The Bureau is accumulating a library which it is hoped will be reasonably comprehensive as regards the matters with which it deals. The Research Branch of the Government Test House is concerned solely with carrying out research work on the lines laid down by the Bureau on the authority of the Advisory Council. The association with the existing organisation of the Government Test House will undoubtedly be of much value to the new branch, since the Government Test House is well equipped and its officers have considerable experience of industrial problems. The subjects for research chosen by the Council include :—

(1) The investigation of the behaviour of paints of different formulæ on exposure to atmospheric and other influences. A considerable amount of work has previously been carried out by the Government Test House on this subject.

(2) The investigation of the behaviour of vegetable oils when used for the lubrication of internal combustion engines. For this purpose the Government Test House will be equipped with a petrol engine of the motor car type together with the necessary cooling devices and other accessories and a dynamometer for measuring the energy output.

(3) The investigation of the behaviour of Indian cement when tested according to the methods proposed to be adopted for the new British Standards Specification and also the behaviour of Indian sands in these tests.

(4) The investigation of various problems affecting the use of lime as a building material.

(5) The investigation of the effect on the properties of dry cells of systematic variation of composition. For this purpose a constant temperature plant will be installed. A considerable amount of work has previously been done in India on dry cells, the manufacture of which appears to be a promising small industry, but a systemat[illegible] investigation of the type proposed nec[illegible] tates working at a fixed tem[illegible]ion of

Otherwise variations of performance arising from differences of composition are, unless they are very marked, obscured by the large temperature effect shown in the watt output of such cells.

(6) A systematic investigation of the different Indian sands and felspars which appear to be suitable for glass making. If use can be made of felspars found in India, one of the problems affecting the glass industry, *viz.*, the fact that it depends on imported soda, will not be solved but at any rate lessened. Various analyses of Indian sands are available but the Tariff Board in its recently published report expresses the opinion that the data were not sufficient. Less attention appears to have been paid to the possibly important question of the utilisation of felspars.

To provide for the expenses of the Bureau and the Research Branch of the Government Test House, the Government of India have sanctioned the expenditure of a sum of five lakhs of rupees spread over three years. The exact apportionment of this sum cannot at present be foreseen but probably, in very round figures, some three lakhs will be spent on the Bureau, including the award of prizes, and two lakhs on the Research Branch of the Government Test House.

The organisation described has not been in existence long enough for it to be possible to forecast with any confidence what its future is likely to be, but it is hoped that the brief account given will give an idea of the lines on which it is at present proposed to work.

Exploration of the Upper Atmosphere by means of Sound Waves.

By K. R. Ramanathan,
Indian Meteorological Department, Poona.

THE maximum height which balloons carrying self-registering instruments have reached is about 35 km. A limit to the attainable height is set by the properties of the fabrics out of which balloons can be made. With improved fabrics it is possible that this height may be exceeded, but this is a problem for the future. An altogether different method for studying the physical conditions in the layers of the atmosphere which lie immediately above the reach of balloons is by the use of sound-waves. Beginning from 1904, when Van d. Borne discussed the propagation of sound-waves proceeding from an explosion of dynamite in Westphalia, the subject has developed considerably. During the second Polar Year, August 1932 to August 1933, a special series of explosions were arranged in Holland and also in the Polar regions. The results of this and other previous work are collected together in a special number of the *Zeitschrift für Geophysik* published last year. A lucid resumé of the present position of the subject and an account of the work done in England in the last decade is contained in the Symons Memorial Lecture delivered in March 1935 before the Royal Meteorological Society of London by Dr. F. J. W. Whipple, the Director of the Kew Observatory, and the foremost worker on the subject in Britain.

Some of the principal features of the propagation of sound from a loud explosion which can be inferred from aural observations can be summarised as below. Surrounding the source of sound, there is a region of 50–60 km. radius in which the intensity of the sound falls off gradually with distance; beyond 50–60 km. the sound is not audible. Going farther from the source, the sound again revives, often sharply, at a distance which may vary from 100 to 200 km. This second "zone" of audibility is often about 100 km. wide. If we calculate the velocity of the sound heard in this region from the distance from the source and the time between the explosion and the time of hearing the report, the computed velocity is found to be much smaller than the velocity corresponding to the temperature prevailing in the lower atmosphere. An explanation of these peculiarities was offered by Van d. Borne himself. In the immediate neighbourhood of the source the sound travels in the lower atmosphere, but that received in the second zone comes not directly, but by a longer path after reflection from the upper atmosphere. Timing the reception of the sound at known distances enables the determination of the delay in making the detour and the results of observations show that the sound gets reflected at heights ranging from 35 to 45 km. in the atmosphere.

Occasionally, the second zone of audibility is followed by yet a third one with a second zone of silence between. The sound received in this zone is due to waves reflected twice from the upper atmosphere and once from the ground.

The hearing of gun-fire at great distances from the battle-front during the European War in 1914–18 provided much interesting new information. It was found that during summer in Europe sounds travelled to great distances to the west, while during winter, they could be heard much farther in the east. The audibility at the same distance in different directions was not also the same. Further progress in the subject came with the organisation of pre-arranged explosions and the development of the technique for the reception of the sound. In the Continent of Europe, special explosions were made by the destruction of surplus munitions and in England advantage was taken of the firing of artillery guns. The receiving instruments used in Germany are based on the principle of magnifying optically the movements of a light piston or stretched membrane at the mouth of a resonator; in England, Tucker's hot-wire microphone is used. The arrival of waves is recorded at a number of places at distances going up to 300 or 400 km. from the source and advantage is taken of the broadcasting organisation to send wireless waves every second for time-marking purposes. An important quantity that is determined in recent work is the angle which the arriving wave makes with the horizontal; this gives the velocity of sound at the topmost part of the trajectory, being equal to $v \sec i$, where v is the velocity of sound near the ground and i the angle which the trajectory makes with the ground. The angle generally lies between 10° and 35°. Knowing the velocity of propagation at the topmost part of the trajectory and the distribution of temperature in the first 30 km., it is possible with certain simple assumptions to complete the trajectories of the sound in the upper atmosphere. The assumptions usually made are that up to a certain height, the velocity of sound in the stratosphere is constant and that above this it increases rapidly. In recent calculations, the influence of wind in the accessible layers of the atmosphere is also taken into account. The calculations show that the downward movement of sound begins at 35–45 km. The increased velocity in the upper atmosphere implies either an increase of temperature or a decrease of molecular weight. For various reasons, the former alternative is believed to be true in the layers under consideration.

The average distribution of temperature in the upper atmosphere over Europe in summer deduced from the collected results of these experiments is shown in Fig. 1.

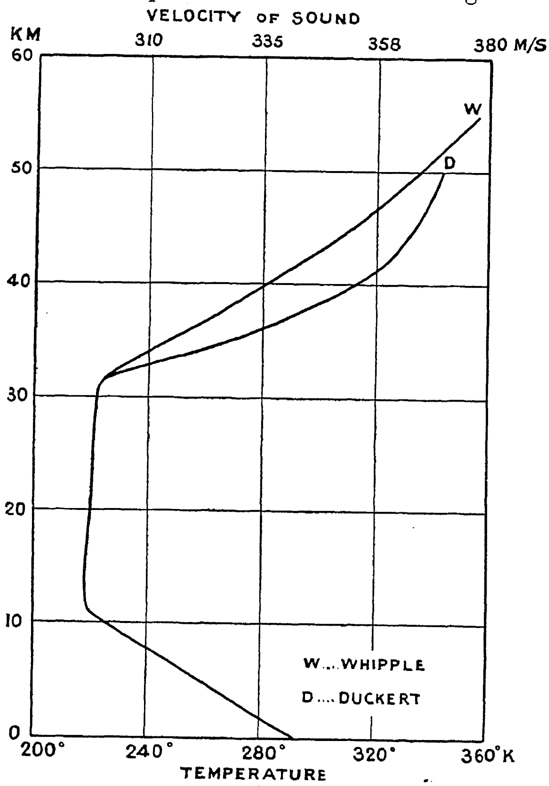


Fig. 1.

The marked difference between summer and winter as regards audibility at stations east and west of the source has already been mentioned. The records of self-registering instruments also show differences of times of travel of sound in different directions which can only be explained by large velocities of the order of 20–40 metres per second in the stratosphere, easterly in summer and westerly in winter. Many other facts such as the movement of persistent meteor trails and luminous night clouds support the same conclusion.

A reason for the strong westerly and easterly winds in winter and summer respectively in European latitudes has been put forward by Whipple. The results of sounding balloon ascents made at Abisko in Lapland during the years 1921 and 1929 showed a remarkable annual variation of

temperature in the stratosphere, the mean temperature at 18 km. changing from 235° A. in June and July to about 210° A. in November to February. This very large change of temperature causes a seasonal change of pressure gradient between the temperate and polar regions causing easterly winds in the stratosphere in summer and westerly winds in winter.

The rise of temperature above 35 km. in the temperate latitudes is generally attributed to the absorption of ultra-violet solar radiation by ozone in the region 2,900–2,200 A.U. Taking the distribution of ozone in the vertical as worked out by Dobson, Götz, and Meetham, and assuming that the main radiating substance in the stratosphere below 50 km. is water-vapour (in such quantities as we may reasonably expect to be present) and carbon dioxide, it is easy to explain the course of temperatures over Europe deduced from experiments on the propagation of sound from explosions. But the fact that even in Polar regions in winter where the atmosphere has not received solar radiation for weeks, the phenomenon of anomalous propagation of sound is observed shows that the above explanation is insufficient.

Observations of the anomalous propagation of sound in the tropical atmosphere are practically absent, the only known instance in low latitudes being those of an explosion of a train-load of gelignite in South Africa in July 1932, when the sound was heard at a distance of 500 km.

It is obvious that the detailed investigation of the propagation of sound to great distances in low latitudes cannot fail to yield results of fundamental importance to the Physics of the Atmosphere. If the sympathetic co-operation of the Indian Military Department can be secured, the problem does not appear to present serious difficulties. Side by side with this, the problem of the vertical distribution of ozone in our latitudes would also have to be investigated.

The Nature and Origin of Insect Colours.

By M. S. Mani.

(From the Laboratories of the Zoological Survey of India, Indian Museum, Calcutta.)

THE nature, origin and significance of the colours of insects have attracted the attention of workers from very early times. Within recent years, great advances have been made along various directions. In this note attention is directed to the recent advances in the subject, in so far as they relate to the nature and origin of insect colours.

The great varieties of colours and markings exhibited by insects naturally fall into two groups: (1) Structural colours, and (2) Pigmentary colours. Structural colours are due to light scattering, reflection, refraction and diffraction effects, as a result of certain peculiarities in the minute structure of the integument of insects and not to special pigments. The pigmentary colours, on the other hand, result from some definite chemical substance such as chlorophyll, melanin, etc. Some insects, as the metallic coloured beetles, owe their brilliant colours to structural peculiarities, while in others like the larvæ of some Lepidoptera, the colours are due to pigments. In most insects, however, combination colours are more prevalent than purely structural colours; pigments exist side by side with structural peculiarities which by themselves are also colour producing. This, for instance, is the case with *Ornithoptera poseidon* investigated by Onslow[1] who found that the green colour of this insect results from a combination of yellow pigment with a structural blue.

It is very difficult to elucidate the origin of structural colours of insects and the results of recent workers differ in several important respects. The white colour of insects is due to the absence of any special pigments and results from the minute structural details of the cuticle irregularly scattering the light waves by multiple reflection and refraction. All the white colours of insects are ultimately to be traced to this source, though it is believed that in a few insects the presence of uric acid in a finely divided state is the cause of white colour. It has, however, been shown that in such cases even after the removal of the uric acid by treatment with dilute alkalies, the white colour remains unchanged. That the white is due to structural peculiarities is

[1] Onslow, H., *Biochem. Journ.*, 1916, **10**, 26.

further shown by the evidence obtained by the disappearance of the white when the air in contact with the white parts is replaced by a colourless liquid of nearly the same refractive index as the chitin of insects. The original white is fully restored when the liquid is removed and the chitinous part dried. The recent researches of Mason[2] further show that a colourless cuticle with an irregular reflecting surface is generally white.

The other structural colours of insects are of two types: (1) the iridescent or the so-called "metallic" colours, and (2) the non-iridescent or the non-metallic colours. The elytra of the metallic coloured beetles, the bodies of the enamelled Rose-chafers (*Cetoniids*) and the metallic Chalcids and the scales of certain brilliantly coloured Butterflies, etc., show marked iridescence. The non-iridescent colours are found only in the larvæ of some Lepidoptera.

Considerable attention has, within recent years, been devoted by such workers as Onslow, Suffert and Mason, to the investigation of the iridescent colours of insects and various causes have been regarded as responsible for them. It is now believed that the iridescent colours of insects are caused by:

(i) Diffraction effect due to the presence of a grooved surface or "grating".

(ii) Interference at surface due to simple or multiple films.

(iii) Tyndall effect or scattering of light waves by particles with diameters less than the wave-lengths of light.

(iv) Selective reflection of a narrow band of the spectrum from an opaque and highly reflecting surface.

According to Mason,[3] the brilliant iridescence of the elytra of the Lamellicorn beetle, *Sericea sericea*, is due to the diffraction effect produced by the fine striæ, about 20,000 per inch, running transverse to the length of the elytra. The iridescence of this beetle, owing to the grating being external, is transferable to collodion impressions. There are other insects recorded by Onslow[4] in which the iridescence is not transferable. This, for instance, is the case with the butterfly, *Morpho cypris*, whose scales are brilliantly iridescent. These instances, however, appear to be exceptions among insects and the general conclusions of Onslow,[4] Suffert[5] and Mason[3] are opposed to the view that diffraction plays an important part in insect colouration. Onslow has further observed instances where the collodion impressions of the gratings are brilliantly iridescent while the insects themselves are not.

Diffraction theory is entirely inadequate in the case of the non-pigmented wings of the Dragon flies, where no grating has yet been shown to exist. The view of most investigators in such cases is in favour of the interference theory. Mason's[3] work seems to show that the iridescence in this case is explainable on the basis of multiple thin films separated by a material of different refractive index, a phenomenon which was comprehensively dealt with by Rayleigh.[6] The recent preliminary studies of the writer indicate that the purplish iridescence of the wings of some species of the Chalcid genera *Leucospis* and *Dirhinus* is also due to interference. Scale iridescence is also explainable on the same lines. The result of swelling and compressing the scales and of permeating them with liquids of the same refractive indices seems to lend support to this view.

Mason[3] divides iridescent scales into three types: (1) *Urania* type, (2) *Morpho* type, and (3) *Entimus* type. In the first type of scales all the colour-producing films are parallel to the surface of the scale, overlaid by rib-like structures. The multiple films are either in the upper or the lower lamina of the scale. Suffert[5] demonstrated that in the second type of scales the reflecting films are situated in the rib-like structures themselves at an angle to the base of the scale, *i.e.*, inclined to it. The optical result of such a structure is a brilliant metallic blue. In the third the films are in the interior of the scales and inclined in different directions, so that corresponding colour patches are produced. This type is seen in various species of the Diamond beetles of the genus *Entimus*. Biedermann[7] and Mallock[8] explained the iridescence of these beetles wholly by the theory of thin films. Michelson,[9] on the other hand, held that stratified

[2] Mason, C. W., *Journ. Phys. Chem.*, 1926, **30**, 383.

[3] Mason, C. W., *Journ. Phys. Chem.*, 1927, **31**, A, 321; B, 1856.

[4] Onslow, H., *Phil. Trans. Roy. Soc.*, 1921, **B 211**, 1.

[5] Suffert, F., *Zeit. Morphol. Ökol. Tiere.*, 1924, **1**, 172.

[6] Rayleigh, Lord, *Proc. Roy. Soc.*, 1917, **A 93**, 565.

[7] Biedermann, W., *Handb. Vergleich. Physiol.*, 1914, **3**, (2 B), 1657-1994.

[8] Mallock, A., *Proc. Roy. Soc.*, 1911, **A 85**, 598.

[9] Michelson, A. A., *Phil. Mag.*, 1911, (6), **21**, 564.

films could not be responsible for the varied colour of scales, and supposed that the effect must be due to diffraction by an internal grating of the scale. He was, on theoretical grounds, able to calculate that the grating should comprise 5,000–10,000 striæ per centimetre and this agreed with actual counts. Onslow postulated that to satisfy this theory it was necessary to suppose that the gratings are of the saw-tooth type, as all the light is concentrated in one spectrum. He did not, however, accept diffraction as the sole cause but concluded that interference by thin films also must play a part in the production of iridescence. Mason,[3] on the other hand, agreed with the earlier workers in explaining iridescence on the basis of the stratified films alone.

Mason's[2] work also seems to show that the blue colour of certain insects, such as the Dragon flies, can be interpreted on the basis of Tyndall effect. According to this view the colour is due to the scattering of light by minute particles of a transparent substance immersed in a medium of a different refractive index to their own. When the size of particles is small as compared with the wave-lengths of light, the shorter waves are scattered, while the longer ones pass unhindered, and the scattered light is of a blue colour.

Experimenting with highly iridescent beetles, Onslow[4] concluded that in some beetles at least the surface film absorbs only a certain part of the spectrum, while the rest is strongly reflected. According to this view the iridescence of these beetles is a case of selective reflection. It is not, however, clear how such a film is formed and Mason[3] has discussed at length the weak points of this theory. According to him the colours of the metallic beetles and the enamelled Rose chafers result from multiple stratified films of considerable thickness lying on the integument. The colours are further supposed to be modified by the action of certain rod-like structures which are arranged in the cuticle perpendicular to the surface.

The main work on the pigmentary colours of insects is perhaps that of Poulton,[10] whose experiments with Lepidopterous larvæ are well known. Recent workers such as Przibram,[11] Glaser,[12] Palmer[13,14] Hungerford,[15] Wigglesworth,[16] Knight,[17] Thompson[18] and Brindley[19] have also contributed materially to our knowledge of the various pigments of the insects.

The pigments most commonly met with in insects are (1) chlorophyll and its derivatives, (2) hæmoglobin and allied pigments, (3) pigments of protein origin, and (4) pigments with purine bases. The spectroscopic investigations of Poulton indicated the presence of chlorophyll and its derivative xanthophyll in the blood and integuments of some caterpillars, such as the green larvæ of some moths. These pigments are absorbed with the food, and do not undergo any marked changes in the blood of the insect. Przibram[11] is opposed to Poulton's conclusions. He does not agree that spectroscopic evidence alone is sufficient to establish the presence of chlorophyll in insects and stresses the necessity of chemical tests. He proposes a new name "Tiergrun" for the green colour of animals. Gerould,[20] however, criticises Przibram's chemical tests as inconclusive and in general agrees with Poulton. In this connection the work of Gräfin von Linden[21] is of special interest; she found that the red and yellow pigments found in the wing scales of the butterflies of *Vanessa* spp. are derived from the chlorophyll absorbed during larval life. The red and yellow colours of Coccinellid and Chrysomelid beetles and the red colour of the Reduviid bug, *Perillus bioculatus*, have been shown by Palmer and Knight[14] to be due to the carotin derived from their food. They also demonstrated the presence of anthocyanin in the vermilion-coloured Aphid, *Tritogenaphis rudbeckiæ*; a similar conclusion was arrived at by Glaser[12] in regard to the red Aphid, *Pterocomma smithiæ*.

Hæmoglobin is of rare occurrence among insects and is only found in some larvæ

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[10] Poulton, E. B., *Proc. Roy. Soc.*, 1873, **B 504**, 417.

[11] Przibram, H., *Pflüger's Arch. Physiol.*, 1913, **153**, 385.

[12] Glaser, R. W., *Psyche.*, 1917, **24**, 30.

[13] Palmer, L. S., *Carotinoids and Related Pigments*, New York, 1922.

[14] Palmer, L. S., and Knight, H. H., *Journ. Biol. Chem.*, 1924, **59**, (A), 443; (B), 451.

[15] Hungerford, H. B., *Canad. Entomol.*, 1922, **54**, 262.

[16] Wigglesworth, V. B., *Proc. Roy. Soc.*, 1924, **B 98**, 149.

[17] Knight, H. H., *Ann. Entomol. Soc. America*, 1924, **17**, 258.

[18] Thompson, D. L., *Biochem. Journ.*, 1926, **20**, 73, 1026.

[19] Brindley, M. H., *Trans. Entomol. Soc. London*, 1929, **57**, 5.

[20] Gerould, J. H., *Journ. Exp. Zool.*, 1921, **34**, 385.

[21] Linden, Gräfin G. von, *Ann. Sc. Nat. Zool.*, 1905, **20**, 158.

of the Dipterous family Chironomidæ. It has recently been found by Hungerford[15] in the Notonectid, *Buenoa*.

The most important pigment of protein origin found in insects is melanin; it is commonly found in many groups. Of the pigments with purine bases, uric acid and its derivatives have been shown by Hopkins[22] to be the cause of white and yellow colour of wings of butterflies of the family Pieridæ.

[22] Hopkins, Sir F. G., *Phil. Trans. Roy. Soc.*, 1896, **B 186**, (2), 661.

The Mathematical Theory of a New Relativity.*

BY SIR SHAH MUHAMMAD SULAIMAN—A CRITICAL REVIEW.

§ 1. In the two papers published in the *Proceedings of the U. P. Academy of Sciences*, the author claims to have given a modification of Newtonian kinematics and Newtonian dynamics which not only yields all the results deducible from relativity but disproves the assumptions of relativity by deriving results more in accord with observation. He further derives some equations which, superficially, at any rate, look like generalisations of relativistic equations and then deduces Newton's forms as first approximations and Einstein's as higher ones. The first article consisting of Chapters 1 and 2 is devoted mainly to the theory of gravitation and the second article consisting of Chapters 3, 4 and 5 deals with Cosmology and questions of special relativity.

The first of these articles was included by Shapley[1] as "one of the high lights of Astronomy during 1934" in his remarks at the annual dinner of the American Association of Variable Star Observers on October 20, 1934.

It is not clear from Shapley's speech whether such a reference was based on a critical study of the article in question or on a tacit assumption, at its face value, of the claims put forward by the author. Quite recently this article has been critically reviewed by D. R. Hamilton,[2] who, confining himself to Sulaiman's explanation of the advance of perihelion, comes to conclusions which suggest that Sulaiman's work is absurdly erroneous. On the mathematical side not much notice has been taken of the work, the *Zentralblatt für Math.*,[3] satisfying itself with a bare mention of the article.

§ 2. Before undertaking a detailed review, a few general observations might be made. In the first place, it must be remarked that for the author to call his theory a new relativity is to give a completely false impression of his own work. If anything at all, the main thesis of the work is purely anti-relativistic and is vehemently opposed to a principle of relativity in any form whatsoever. Further one is struck by the large preponderance of books on popular expositions of relativity in the references to literature given at the end of the articles and this perhaps gives a clue to the great aversion to relativity which is manifest in the author's work. For, as is well known, the champions of the Theory of Relativity too often delight to bring forward those results of the theory which appear to them to be specially fitted to shock the common sense of people who take statements too literally and relativity is not the only example of a physical theory which appears absurd when its logical consequences are pushed to their very limit. In the list of references placed at the end of the second article it is curious to find the book "*Mysterious Universe*" ascribed to Eddington.

There are some mis-statements of facts in the author's references to relativity the most serious of which are in connection with the observational verifications of the general Theory of Relativity. The author says, (p. 4, Ch. 1), "It is now established that the supposed verifications are not exact," but the references to literature in support of this statement do not refer to the best observational data which are universally accepted. For the advance in the longitude of perihelion of Mercury the observational value is given as 40″·00 per century (the reference being to Eddington's *Mathematical Theory of Relativity*) whereas the best determinations are due to Chazy[4] and give 43″·5 as against the

* The Mathematical Theory of a New Relativity by Sir Shah Muhammad Sulaiman, *Proceedings of the U. P. Academy of Sciences*, 1934–35, Vol. IV. Part 2, pp. 1-36 and Vol. IV, Part 4, pp. 217–261.

[1] *Science*, 1934, **80**, 439.

[2] *Science*, 1935, **81**, 271–272.

[3] *Zentrablatt für Math.*, 1935, **10**, 88.

[4] *Comptes Rendus*, 1926, **182**, 1134.

theoretically predicted 42″·9. In the case of the gravitational deflection of light the author refers on p. 25, Ch. 1, to values obtained at several eclipse expeditions but significantly omits to mention the most satisfactory data available at present, *viz.*, those of Campbell and Trumpler,[5] who obtained the results 1″·72±0″·11 and 1″·82±0″·15 with two different sizes of cameras in the 1922 expedition of the Lick Observatory. As regards the gravitational shift of spectral lines a reference is made to the older work of St. John as quoted in Eddington's *Math. Theory* whereas in the cases of *both* the Sun and the dense companion to Sirius the agreement between the Theory of Relativity and observation is quite satisfactory as a result of the later work of St. John[6] and of Adams.[7] It appears therefore that the claims of Sulaiman's theory that it gives results more in accordance with observation than relativity are to be taken with some reservation. Other mis-statements of a minor nature are that relativistic invariance holds in vacuum only (p. 3, Ch. 1), that Einstein arbitrarily assumes $c+v=c$ and $c-v=c$ (p. 32, Ch. 2), that Milne's theory *ignores* gravitation and *evades* collisions (p. 224, Ch. 3) and that, in relativity, time is *wholly imaginary* and space *illusory* (p. 253, Ch. 5).

The mathematical part of the work is quite elementary and does not go beyond the solution of an ordinary differential equation of the second order. Looking from an æsthetic-mathematical point of view, one searches here in vain for such concepts like groups, tensors and generalised spaces characteristic of relativity or functional equations, sets of points, and Finsler spaces relevant to Milne's new relativity. On the other hand we have a set of drab differential equations as a series of approximations ninety per cent. of which is not relevant even to the author's own work. In dealing with the relativistic equation of a planetary orbit the exact solution of which can, as is well known, be expressed in terms of elliptic functions, the author claims to have devised a method superior to the methods of Forsyth, Morley and Pierpoint (p. 14, Ch. 1). A little scrutiny however shows that this superiority of method is achieved at the cost of a little wrong mathematics (*see* Section 9, p. 14, Ch. 1).

To obtain a solution of

$$\frac{d^2u}{d\theta^2}+u-\frac{3\mu}{D^2}u^2=\frac{\mu}{h^2}(1-2k\theta) \quad .. \quad (2.1)$$

the author considers the solution of

$$\frac{d^2u}{d\theta^2}+u-\frac{3\mu}{D^2}u^2=0 \quad .. \quad .. \quad (2.2)$$

which is correctly obtained as

$$u=\frac{D^2}{6\mu}+\wp\left\{\frac{\sqrt{\mu}}{D\sqrt{2}}(\beta-\theta)\right\}.$$

It is then stated that the solution of (2.1) is given by

$$u=\frac{\mu}{h^2}(1-2k\theta)+\frac{D^2}{6\mu}+\wp\left\{\frac{\sqrt{\mu}}{D\sqrt{2}}(\beta-\theta)\right\} \quad .. \quad (2.3)$$

presumably on the strength of the theorem that the general solution is the sum of the complementary function and a particular integral. It is, however, absurd to use this theorem here since it cannot apply to nonlinear differential equations like (2.1) and, moreover, $\mu(1-2k\theta)/h^2$ is not a particular integral.

As examples of the author's attitude towards scientific investigation we might mention his views (1) that Nature's limits are not fixed by our capacity to observe them (p. 230, Ch. 4), (2) that relative velocity cannot mean relative velocity as actually observed and we cannot go by measurements only (p. 242, Ch. 5), and (3) that a certain concept in relativity is unacceptable because the concept is philosophically an impossible one (p. 226, Ch. 3).

Finally on a point relating to a question of priority, it is highly amusing to see the author refer to a paper by P. Jordan mentioning gravitational quanta and claim priority by pointing out that his own theory was published in 1933 and again in 1934. It might be pointed out that, if it be a question of the "gravitons" of the Sulaiman type subject to the impulsive pulls and pushes of Newtonian dynamics, a whole literature[8] about them already exists. These "gravitons" have in fact a very close family resemblance to the "corpuscules ultramondains" of Le Sage,[9] the "radiating

[5] *Lick Observatory Bull.*, 1923, **11**, 41 and 1928, **13**, 130.

[6] *Astrophysical Journ.*, 1928, **67**, 195.

[7] *Proc. Nat. Acad.*, 1925, **11**, 382.

[8] J. Zenneck, Article on "Gravitation" in the *Ency. Math. Wiss.*, **Bd. V2**, §§30-33, 57-63.

[9] *Berlin Mém.*, 1782.

atomules" of O. Keller,[10] and the "residual attraction" of Crehore.[11] If, on the other hand, it be a question of gravitational quanta the possibility of whose existence is a consequence of the complementarity of the wave and corpuscular aspects of modern quantum mechanics, it is needless to say that such a concept is now quite well known for a number of years and finds a place even in elementary books on wave mechanics.[12]

§ 3. GENERAL RELATIVITY. (*a*) *Advance of Perihelion.*—The two main ideas which the author uses for dealing with gravitational phenomena are the finiteness of the velocity of propagation of gravitation and the introduction of a correction to Newton's law for the case of moving bodies. Both these ideas have no novelty in them going back in fact to the work of Laplace[13] and a series of later investigators.[14] Laplace himself did not assume any variations of Newton's law for moving bodies but only the finiteness of the velocity of propagation. He was thus led to apply a sort of an *aberration principle*, but his results were completely against all observed values in planetary perturbations. Assuming D the velocity of propagation of gravitation equal to c the velocity of light, his theory did not correctly give the advance of Mercury's perihelion and, in addition, gave a secular variation of the mean longitude contrary to observation. An attempt to bring down this secular variation to the observed value necessitated the assumption that $D=500\,c$. It was later shown by Lehmann-Filhès[15] that such an attempt in the case of the perturbation of the moon's longitude required the assumption for D a value nearly a million times c.

Coming now to theories which assume both the finiteness of D and a modification of Newton's law we have the theories of Weber, Riemann, Gauss, Neumann, Clausius, Anding and Gerber. On the unsatisfactory nature of the first five theories reference may be made to the sources[16] mentioned above and we might confine our attention to the last two, specially to Gerber's theory which bears a great resemblance to Sulaiman's work. Anding[17] substituted for the Keplerian equations of motion the following equations

$$\frac{d^2x}{dt^2}+\frac{\mu x}{r^3}=\frac{\mu}{c}\cdot\frac{x}{r^3}\cdot\frac{dr}{dt};$$
$$\frac{d^2y}{dt^2}+\frac{\mu y}{r^3}=\frac{\mu}{c}\cdot\frac{y}{r^3}\cdot\frac{dr}{dt}$$

in order to explain the perihelion advance of Mercury, but these give rise, in addition, to a large perturbation in the eccentricity which is quite contrary to observation. Gerber[18] started with an expression for the potential in the form

$$P=k^2m_1m_2:r\left[1-\frac{1}{D}\frac{dr}{dt}\right]^{\alpha}$$

and determined the constant α in order that the perihelion advance thus given may equal the observational value which he took $41''.25$ per century (with $D=c$). He thus obtained two possible values of α, *viz.*, $\alpha_1=2$ and $\alpha_2=-3$ and assumed the former value for his correction to Newton's law. It is remarkable that the other value $\alpha_2=-3$ gives Sulaiman's law if we observe that it is derivable from the above potential, remembering that Sulaiman's correction factor does not depend on r. The criticisms levelled against Gerber's theory therefore apply to Sulaiman's theory equally well and reference in this connection might be made to the remarks of Seeliger,[19] Laue[20] and Oppenheim.[21] Any one who has worked in the perturbation theory of celestial mechanics knows quite well that modifications of the Newtonian law introduced to explain a certain anomaly give rise to unforeseen perturbations in other elements of the planetary orbit. This is exactly what happens with Gerber's theory which, like the theory of Anding, gives unwanted perturbations in the eccentricity or alternatively an assumption that D is nearly 10^4c. We should therefore expect similar absurdities to arise in Sulaiman's theory and this has been confirmed by Hamilton who has shown that this theory gives an yearly increase of eccentricity equal to $0\cdot0026$

[10] *Comptes Rendus*, 1908, **147,** 853–56.
[11] *Electrical World*, 1912, **59,** 307–11.
[12] See for *e.g.*, J. Frenkel, "Introduction to Wave Mechanics," who uses the word 'gravons'.
[13] *Méc. cél.*, **4,** Livre. X, Chap 7.
[14] See (8) above, §§ 20 and 21–24. Also S. Oppenheim, Article on "Kritik des Newtonschen Gravitationsgesetzes," *Ency. Math. Wiss.*, **VI** 2, 22, § 31, 152–58; also F. Tisserand, *Méc. cél.*, **4,** Chapter 28.
[15] *München, Ber.*, 1895, **25,** 371.
[16] See references (8) and (14) above.
[17] *Astr. Nachr.*, 1924, **220,** 353–60.
[18] *Ann. d. Phys.*, 1917, **52,** 415.
[19] *Ibid.*, **53,** 31 and **54,** 38.
[20] *Ibid.*, **53,** 214. Also Article on "Relativitätstheorie" by W. Pauli in *Ency. Math. Wiss.*, **V,** 19, §58, 732.
[21] *Ann. d. Phys.*, **53,** 163.

which means that Mercury goes off in a parabolic orbit within about three centuries! Alternatively an attempt to bring down this perturbation in eccentricity to Newcomb's value of $(-4 \cdot 3 \pm 2 \cdot 5 \times 10^{-8})$ per year requires the assumption $D = 6 \times 10^4 c$!

It would not be out of place to mention here other theories relating to the advance of Mercury's perihelion. We have Asaph Hall's[22] alteration of the law of Newtonian attraction from r^{-2} to $r^{-(2+\delta)}$ which gives the required perihelion advance if δ be put equal to $0 \cdot 00000016$ but, apart from its arbitrary nature, it gives a movement of 135″ in the apse of the Moon which is negatived by observation. Again the assumption of the oblateness of the Sun[23] explains the perihelion advance but gives very large perturbations of the inclination of Mercury's orbit. Finally the zodiacal theory of light[24] also gives rise to unwanted perturbations. One is therefore led, almost by a process of exhaustion, to Einstein's theory which by its very nature does not give any perturbations.

(*b*) *Gravitational Deflection of Light.*—The author's derivation for the deflection of light of a value equal to 4/3 times the Einstein value can only be described as truly amazing! He states (Ch. 1, p. 4) that Gerber's equation does not yield the value for the deflection which is certainly true and the same should also be true of Sulaiman's equations if properly handled. His method consists in taking the equation

$$\frac{d^2u}{d\theta^2} + u = \frac{\mu}{h^2} + \frac{3\mu}{D^2} u^2 \ (D = c) \quad .. (3 \cdot 1)$$

as the differential equation of the path of a light particle in a gravitational field. This equation is the relativity equation for the path of a material particle and in Sulaiman's theory it is only an approximate equation (*viz.*, the third approximation) there being approximations of four higher orders. The general equations of Sulaiman's theory are obtained by treating v (velocity of the particle) as small compared with D and consequently neglecting higher powers of $\left(\frac{1}{D}\frac{rd\theta}{dt}\right)$ than the first. It is therefore obvious that when one is dealing with the motion of a particle whose velocity is D itself (*i.e.*, a light particle, since D is taken equal to c), it is wrong to start with an approximate equation. The author himself sees the need of this when he is dealing with the motion of an electron in connection with his explanation of the fine structure of spectral lines (Ch. 5, p. 258). The straightforward thing to do in this case is to write down the equations of motion *ab initio* using the relation $v = D$ and when this is done with the equations in Sec. 5, Ch. 1, p. 9, we easily obtain the equation to the path of the light particle

$$\frac{d^2u}{d\theta^2} + u = 0 \quad .. \qquad .. \qquad .. (3 \cdot 2)$$

that is, a straight line showing that there is no deflection for a light particle in a gravitational field! This could also be *qualitatively* verified from Sulaiman's law of attraction, *viz.*,

$$-\frac{\mu}{r^2}(1 - v/D)^3 \text{ by putting } v = D$$

and is in consonance with what Gerber's equations can give for the deflection. Thus while on the old pure Newtonian theory we could deduce a deflection at least equal to half the Einstein value, this generalisation by Sulaiman yields no deflection at all!

Assuming for a moment that (3.1) correctly gives the path of a light particle, the author still fails to justify his final result, for when he states (Ch. 2, p. 25) that $r\frac{d\theta}{dt}$ can never exceed the *tangential velocity c*, he assumes unconsciously that the tangential velocity is constant, but this cannot certainly be true. Even in the derivation of the deflection on Newtonian mechanics c is assumed to be the velocity at infinity of the light particle. The assumption of a constant tangential velocity is equivalent to taking the central orbit as circular and it becomes meaningless to talk of the deflection as the angle between the asymptotes of the orbit. Such circular orbits[25] are also possible for light particles according to general relativity but they are excluded[26] for purposes of obtaining the deflection.

There is a third mistake in this derivation of the deflection. By showing that the least value of the expression on the right hand side of (3.1) is $\frac{4\mu}{D^2}u^2$ $(D = c)$ the conclusion

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22 *Astr. Journal*, **14**, 45.

23 See A. C. D. Crommelin, *Nature*, 1920–21, **106**, 788.

24 See H. Jeffrey's *M.N.R.A.S.*, **80**, 138.

25 D. Hilbert, *Gott. Nachr.*, 1917, 73–75.

26 Laue, "Relativitätstheorie," **Bd. 2**, §24, 224–27.

is drawn that the deflection *is* exactly 4/3 times the Einstein value, but the correct conclusion to draw is that it *is at least* 4/3 that value. In a case like this where observational verification is essential one would naturally enquire what would be the *maximum* deflection possible, but the work is silent on this point!

(c) *Shift of Spectral Lines.*—No remarks appear to be necessary in this case for, according to the author's own showing, the "corrections provided by the 'New Relativity' are not appreciably large and the value of the ratio is the same as Einstein's" for spectral lines in the solar spectrum. For planetary spectra he remarks, "Unfortunately the ratios for the planets are too small as compared to that of the Sun and the more accurate formulæ cannot give any better results at present."

Having examined the achievements of this 'New Relativity' in the three crucial tests, we can well conclude by saying that no one would seriously think of adopting it as an alternative to the general theory of relativity for the explanation of gravitational phenomena.

§ 4. SPECIAL RELATIVITY. (*a*) *Relative Velocity.*—The author enunciates his 'first universal principle' as follows (Ch.5, p. 247):

The relative velocity v between two bodies moving with velocities u and v′, measured by employing a messenger travelling with a velocity D in a to-and-fro journey, is given by the formula

$$\frac{v}{v'-u} = \frac{\mathrm{D}(\mathrm{D}+v'-u)}{(\mathrm{D}+v')\,(\mathrm{D}-u)} \quad .. \quad (4.1)$$

and claims that this formula is more general than the corresponding formula of special relativity

$$v = \frac{v'-u}{1-\dfrac{v'u}{c^2}} \quad .. \quad .. \quad .. \quad (4.2)$$

by showing that (4.2) is an approximation obtained from (4.1) by neglecting terms like $(v'^2u-v'u^2)/\mathrm{D}^3$, etc.

It is difficult to see how a correspondence could be established between (4.1) and (4.2) if it be noted that in the derivation of (4.1) the notions of absolute space and absolute time are retained while these are foreign to relativity. (4.1) applies even to the case where u and v' are velocities relative to an observer who is at rest in his own system, while in such a case both classical and relativistic kinematics give $v'-u$ for the relative velocity. As an example of confused thinking it is hard to find anywhere in relativistic literature a parallel to the author's derivation of equation (4.1). An absolute distance between two moving points is assumed as r independent of all measurement and on this are made to depend a real and an apparent distance. This leads on to the notions of absolutely real relative velocities, apparently real relative velocities and really apparent relative velocities! Let us however assume that (4.1) actually corresponds to the relativistic equation (4.2). We can then deduce some absurd consequences.

(i) Putting $v'=\mathrm{D}=c$ in (4.1) we deduce $v=c-u/2$ while classical kinematics gives $v=c-u$ and relativity gives $v=c$. We can therefore describe the Sulaiman kinematics as a sort of a hybrid form or as a sort of a semi-emission theory similar to the emission theory of Ritz.[27] Sulaiman's kinematics founders therefore on the rock of de Sitter's binary star test[28] as all other emission theories do.

(ii) Formula (4.1) looks superficially like a generalisation of Einstein's formula for addition of velocities and the author applies it to derive Fresnel's formula for the dragging coefficient and claims to have obtained a better approximation than the usual expression

$$c'_1 = c_1 - u\left(1-\frac{1}{\mu^2}\right) \quad .. \quad .. \quad (4.3)$$

where c'_1 is the velocity of light in moving water, $c_1=c/\mu$ the velocity in stationary water and u the velocity of the water. The corresponding expression deduced from (4.1) reads

$$c'_1 = \frac{\left(c_1-u\right)\left(1+\dfrac{c_1}{c}-\dfrac{u}{c}\right)}{\left(1+\dfrac{c_1}{c}\right)\left(1-\dfrac{u}{c}\right)} \quad .. \quad (4.4)$$

The actual reduction of (4.4) to an equation of the same form as (4.3) (which the author has not carried out) gives after a slight simplification

$$c'_1 = c_1 - u\left[1-\frac{1}{\mu(\mu+1)}\right] \quad .. \quad (4.5)$$

In the case of water (4.3) gives for the second term on its right hand side the value of $0{\cdot}44\,u$ which has been well confirmed by the

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[27] *Ann. de. Chim. et Phys.*, 1908, **13**, 145.

[28] *Proc. Amsterdam Acad.*, 1913, **15**, 1297 and 1913, **16**, 395.

experiments of Fizeau[29] and the later very accurate researches of Zeeman.[30] On the other hand formula (4.5) gives in the same case the absurdly high value of $0\cdot 68\,u$ which is contrary to all observational results.

We can therefore safely dismiss as idle speculation all the results derived on the basis of this 'universal principle' and in particular the ridiculous analogues to Lorentz transformations on pp. 247-48, Ch. 5, between two moving systems which have a common time $t=t'$!

(*b*) *The Principle of Aberration* (Ch. 5, p. 251).—This principle which follows as a consequence of the finiteness of the velocity of propagation of a force has been mentioned already in connection with Laplace's theory of gravitation and is made extensive use of by the author who takes it as his second universal principle. According to him it is merely the necessary result of the compounding of two dynamical velocities, but it is difficult to see any justification for the reduction in the intensity of force along its apparent direction. It really makes no sense to say that when the velocity of flow is D, the effective *component of force* observed along the apparent direction *is D cos α*. There is an utter confusion here between velocity and force. This confusion is also responsible for the meaningless phrase "*the velocity of light* ON *a body moving with velocity v*". The claim of universality of application of this principle is belied by assuming that in the case of light the velocity is reduced while in other cases the intensity of force is changed (for example H in the explanation of Bucherer's experiment). There is yet another inconsistency in the application of this aberration principle to the case of "gravitons". The universality claimed would certainly require the modification in Newton's law of attraction to be $-\frac{\mu}{r^2}:\left(1+\frac{v^2}{D^2}\right)^{\frac{1}{2}}$ leading on to Gerber's equations, but the author uses, instead, the factor $\left(1-\frac{v}{D}\right)^3$ deduced from special consideration of 'graviton' pulls.

In his explanation of Minkowski's equation and of the possibility of velocities exceeding that of light the equations made use of are

$$\left.\begin{aligned} c_1 &= c\cos\alpha \\ \tan\alpha &= v/c \end{aligned}\right\} \qquad \ldots \qquad \ldots (4\cdot 6)$$

where c_1 the apparent velocity of light has its direction perpendicular to that of v and α is the angle of aberration. If, as the author states, the principle of aberration is merely the result of compounding dynamical velocities it is impossible to see how both the equations in (4.6) could be simultaneously true. It is on the basis of such 'flawless' mathematics that the possibility of velocities up to ∞ is deduced and one might well suggest to the author the derivation of his first universal principle when one of the bodies is moving with such a velocity, for example a velocity greater than that of the messenger employed.

(*c*) *Michelson and Morley Experiment.*—The explanation offered is briefly as follows:—

Time of longitudinal journey

$$= \frac{l}{c+v} + \frac{l}{c-v}$$

$$= \frac{2lc}{c^2-v^2} \qquad \ldots \qquad \ldots \qquad \ldots (4\cdot 7)$$

Time of transverse journey

$$= \frac{2l}{\sqrt{c_1^{\,2}-v^2}} \qquad \ldots \qquad \ldots \qquad \ldots (4\cdot 8)$$

where c_1 is the same quantity as in (4.6).

Hence the difference in times

$$= \frac{2lc}{c^2-v^2} - \frac{2l}{\sqrt{c_1^{\,2}-v^2}}$$

$$= \frac{2lc}{c^2-v^2} - \frac{2l}{\sqrt{c^2-2v^2}} \text{ using } (4\cdot 6)$$

$$= -\frac{l}{c}\left(\frac{v}{c}\right)^4 \text{ nearly,}$$

which cannot be detected by experiment.

By using the author's own 'universal principles' it can easily be shown that this explanation is untenable. For, according to the first universal principle of relative velocities, (4.7) should be replaced by

$$\frac{l}{c-v/2} + \frac{l}{c+v/2} = \frac{2lc}{c^2-v^2/4} \qquad \ldots (4\cdot 9)$$

Again (4.8) is obtained by a wrong application of the second universal principle according to which the effect of a finite velocity of flow is the same *as if the body were stationary* and the direction of flow were shifted forward by an angle α and the velocity changed from c to c_1. It is therefore wrong to again compound c_1 with v and hence (4.8) should be replaced by

$$\frac{2l}{c_1} = \frac{2l}{\sqrt{c^2-v^2}} \qquad \ldots \qquad \ldots (4\cdot 10)$$

Hence the difference in times

$$= \frac{2lc}{c^2-v^2/4} - \frac{2l}{\sqrt{c^2-v^2}} = -\frac{l}{c}\cdot\frac{v^2}{2c^2}$$

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[29] *Comptes Rendus*, **1851**, **33**, 349.

[30] *Amsterdam Proceedings*, 1914, **23**, 245; 1915, **24**, 18.

which can certainly be measured but is contradicted by the null result of the Michelson-Morley experiment.

(*d*) *Fine Structure of Spectral Lines.*—The author has not derived the formula for fine structure on the basis of his own theory but only talked about in a certain hazy way which tends to suggest that he is unaware of the methods of even the old Bohr-quantum theory. One would naturally start with the proper expression for the Hamiltonian, then set up the Hamilton-Jacobi equation and introduce the angle and action variables, the quantum conditions being derived by equating the non-degenerate action variables to integral multiples of Planck's constant. Nothing of the sort is done here and it is suggested that the same equations of Newtonian form as used for planetary orbits should be employed with the retention of the term $\left(\frac{1}{D}\,\frac{rd\theta}{dt}\right)^2$ and the reader is left to proceed as best as he can with the help of the third universal principle which deals with the force acting on a spinning spherical shell. It is really a complete mystery what this universal principle has got to do with the motion of an electron in a central field of force and where this spinning spherical shell comes into the picture. In the absence of any quantitative results, it is impossible to attach any weight to the author's explanations.

§ 5. COSMOLOGY. We may well spare the author the joy of his profound cosmological speculations and trenchant criticism of other cosmological theories and proceed to examine those positive results of his theory which are expressed in a mathematical form. The only such result is the derivation of Hubble's famous velocity-distance law on the basis of the author's emission theory of matter and the conclusion therefrom that not only velocities of recession of nebulæ but also velocities of approach are possible. The fundamental equation is

$$\frac{d^2R}{dt^2} = \gamma\frac{dR}{dt} \quad \ldots \quad \ldots \quad \ldots \quad (5\cdot1)$$

where R may be measured in any direction and from any origin and $\gamma = \frac{n\mu}{3}$, n being the number of gravitons emitted from unit mass per unit time and μ the mass of each graviton. From (5.1) we obtain by integration

$$\frac{dR}{dt} = \gamma R + A_0 \quad \ldots \quad \ldots \quad (5\cdot2)$$

which is the expression for the velocity-distance law. From (5.1) also follows a cosmological principle that the relation of acceleration and velocity presents the same picture to all observers. It might be observed, in passing, that this cosmological principle can be considered as a particular form of Milne's principle of equivalent observers. On the basis of (5.2) it is claimed that velocities of recession and approach are both possible.

It might be remarked in the first place that the deep-lying velocity-distance proportionality could be very simply deduced[31] from pure classical *kinematic* considerations only on the basis of a cosmological principle of equivalent observers of the type derived by the author himself. Even in relativistic cosmology it is a simple deduction[32] from the form of the metric assumed in non-static models of the Universe. It appears therefore that it is quite redundant for the purposes of deriving Hubble's law to invoke the aid of an emission theory of matter which calls to aid supernatural agencies for the production of gravitons by the explosion of a sub-atomic shell.

It is again wrong to say that (5.2) explains both recession and approach. For, since R can be measured in any direction and from any origin, a simple change or origin reduces (5.2) to the equivalent form

$$\frac{dR}{dt} = \gamma R \quad \ldots \quad \ldots \quad \ldots \quad (5\cdot3)$$

and γ, by its very definition, is a *positive* quantity unless one were to indulge in Schuster's[33] "holiday dreams" of negative masses. Thus (5.3) shows that $\frac{dR}{dt}$ has always the same sign as R, *i.e.*, the velocity is one of recession. All the enchanting speculation about approaching and receding nebulæ and a stable Universe are therefore seen to be without a foundation. Finally the author's criticism of relativistic cosmology loses much of its force if it be observed that he confines himself to the de Sitter static model whereas the trend of modern work[34] is in the direction of considering non-static models as better suited to explain observed facts.

B. S. M.

Received 20th August, 1935.

[31] E. A. Milne, *Relativity, Gravitation and World Structure*, 1935, §§ 71–72, 73–74.

[32] R. C. Tolman, *Relativity, Thermodynamics and Cosmology*, 456.

[33] *Nature*, 1898, **58**, 367 and 618.

[34] Tolman, *ibid.*, Chap. X, Part IV, 445.

The Particle Problem in the General Theory of Relativity.

IN a recent paper published in the *Physical Review* (Vol. **48**, 73), A. Einstein and N. Rosen have called attention to a possibility of accounting for atomic phenomena by the method of general relativity. Their essential idea consists in removing the singularities of the solutions of the field equations by a simple modification.

One will then have to treat physical space as consisting of two congruent sheets, the particle (neutral or electrical) being interpreted as a portion of space connecting the two sheets, *i.e.*, as a kind of bridge. The determinant of the components of the metric tensor vanishes at the surface of contact of the two sheets. Next, they recognise in the postulate of relativity which states that the motion of a particle takes place along a geodesic, a defect that the field and motion have been separated out. Einstein and Rosen regard that the concepts of particle and motion have to be treated as a part of the field itself. If there are several particles present, one should find a solution free from singularities of the space consisting of two sheets connected by many bridges if he adopts the above point of view. However, one cannot say whether regular solutions with more than one bridge exist at all.

The new field equations adopted by Einstein and Rosen are

$$g^2 R_{kl} = 0$$

instead of the old equations. This adoption would remove the singularities caused in the field equations by the vanishing of the g factors in the denominators of R_{kl}. The regular solution for the spherically symmetric static case is now

$$ds^2 = -4(u^2+2m)du^2 - (u^2+2m)^2(d\theta^2+\sin^2\theta d\phi^2) + \frac{u^2}{u^2+2m}dt^2$$

$$u^2 = r - 2m$$

instead of the Schwarzschild solution,

$$ds^2 = -\frac{1}{1-2m/r}dr^2 - r^2(d\theta^2+\sin^2\theta d\phi^2) + (1-2m/r)dt^2$$

which has a singularity for g_{11} when $r=2m$. In the new solution g vanishes when $u=0$, as g_{44} vanishes. The space can now be regarded as made up of two equivalent sheets corresponding to $u>0$ and $u<0$ joined by a plane $u=0$ or $r=2m$. Einstein and Rosen conceive of a bridge-like connection between the two sheets. They interpret it as a mathematical representation of an elementary, electrically neutral particle. This representation accounts for the non-existence of an elementary particle with negative mass, for one cannot regularise the Schwarzschild solution if it is so.

Just as in the above case of pure gravitational field, Einstein and Rosen have modified the field equations when both gravitation and electricity are present by multiplying the field equations by the factor g^2 and changing the sign of T_{ik}. They find the regular solution for a static spherically symmetric case with an electrostatic field as

$$ds^2 = -du^2 - (u^2+\epsilon^2/2)(d\theta^2+\sin^2\theta d\phi^2) + [2u^2/(2u^2+\epsilon^2)]dt^2$$

$$u^2 = r^2 - \epsilon^2/2$$

taking $m=0$. Einstein and Rosen believe that the massless solutions are the physically important ones to interpret an elementary electrical particle. One can see that the above solution is free from singularities and that the space is divided into two congruent sheets and that the charge is represented by a bridge between the two sheets. According to this, the most elementary electrical particle has no gravitating mass.

In the conclusion, they say, "Nevertheless one should not exclude *a priori* the possibility that the theory may contain the quantum phenomena. Thus it might turn out that only such regular many-bridge solutions can exist for which the 'charges' of the electrical bridges are numerically equal to one another and only two different 'masses' occur for the mass bridges, and for which the stationary 'motions' are subject to restrictions like those which we encounter in the quantum theory. In any case here is a possibility for a general relativistic theory of matter which is logically completely satisfying and which contains no new hypothetical elements."

N. S. N.

Letters to the Editor.

CONTENTS.

Diamagnetism of the Trivalent Bismuth Ion.

THE diamagnetic susceptibilities of a number of ions have been calculated by Pauling,[1] Stoner,[2] Slater[3] and Angus.[4] These theoretical considerations have enhanced the interest in the experimental determinations of ionic susceptibilities.

We have determined the diamagnetic susceptibilities of a number of trivalent bismuth salts by the aid of the Bhatnagar-Mathur Magnetic Interference Balance.[5] The value for χ_A for Bi^{+3} has been calculated by subtracting the value of the susceptibility of the negative ion from the experimentally determined value of the molecular susceptibilities of the salts.

Most of the values of χ_A for the negative ions have been taken from Kido's careful investigations.[6] For Cl′, the value 19·8 as experimentally determined in this laboratory[7] has been used. The χ values for $(PO_4)'''$, O″, and S″ have been taken from the International Critical Tables; the value of $(CrO_4)''$ has been calculated from that of H_2CrO_4 and the value for the citrate ion has been calculated from the values of χ for carbon, hydrogen and oxygen atoms as given in the International Critical Tables.

The results obtained are shown in the table below.

Salt	$-\chi_a \times 10^6$	$-\chi_m \times 10^6$	$-\chi_A \times 10^6$ for Bi^{+3}
Bismuth oxide Bi_2O_3	0·170	79·22	42·20
Bismuth hydroxide $Bi(OH)_3$ ..	0·253	65·78	40·28
Bismuth trichloride $BiCl_3$	0·316	99·65	40·10
Bismuth tribromide $BiBr_3$	0·328	146·94	42·84
Bismuth triiodide BiI_3	0·340	200·53	40·93
Bismuth sulphide Bi_2S_3	0·240	123·40	38·45
Bismuth phosphate $BiPO_4$	0·254	77·22	41·72
Bismuth sulphate $Bi_2(SO_4)_3$ ..	0·282	199·14	41·07
Bismuth chromate $Bi_2(CrO_4)_3$ ..	—0·202	—154·33	43·45
Bismuth citrate $BiC_6H_5O_7$ ..	0·302	120·20	41·38

The value of χ for Bi^{+5} has been calculated by Angus. The value for Bi^{+3} which is the commonest bismuth ion does not seem to have been calculated by either the Slater or the Angus method. In view of the experimental data available, we have calculated

the theoretical value of χ for Bi^{+3} by the Slater method, as a comparison of the theoretical and the experimental values should be of considerable interest.

The gram atomic susceptibility χ_A is given by the expression :

$$\chi_A = -\frac{e^2 L}{6mc^2} \Sigma_N r^{-2} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

According to Slater, the values of r^{-2} are given by

$$r^{-2} = \frac{(n')^2(n'+\frac{1}{2})(n'+1)}{(z-s)^2} \quad \ldots \quad \ldots \quad (2)$$

The values of χ_A can therefore be obtained according to equation (1) by summing over all the electrons remembering that r^{-2} in (2) is given as a multiple of a_0^2 where a_0 is the radius of the innermost orbit in hydrogen ($a_0 = \cdot528 \times 10^{-8}$). This gives

$$-\chi_A \times 10^6 = 0 \cdot 790 \ \Sigma \frac{(n'^2)(n'+\frac{1}{2})(n'+1)}{(z-s)^2} \quad (3)$$

Calculating the values of r^{-2} for different electronic groups in Bi^{+3} and summing up, the value of Σr^{-2} is found to be 55·448. Substituting this value in (3) the atomic diamagnetic susceptibility of Bi^{+3} comes to be $43 \cdot 8 \times 10^{-6}$.

The value of χ_A for Bi^{+3} has been experimentally found to be 41·24 and is in close agreement with the theoretical value 43·8 calculated according to Slater's method. Angus has introduced a slight modification in Slater's formula for evaluating the effective nuclear charge. This modification has the effect of lowering the calculated value for susceptibility and would bring it in closer agreement with the experimental value.

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September 4, 1935.

[1] Pauling, *Proc. Roy. Soc.*, 1927, **A 114**, 181.
[2] Stoner, *Proc. Leeds Phil. Soc.*, 1929, **1**, 484.
[3] Slater, *Phys. Rev.*, 1930, **36**, 57.
[4] Angus, *Proc. Roy. Soc.*, 1932, **A 136**, 569-578.
[5] Bhatnagar and Mathur, *Phil. Mag.*, 1929, **8**, 1041.
[6] Kido, *Science Reports of the Tohoku Imperial University*, Series I, Vol. XXI, No. I.
[7] *Cf Phil. Mag.*, 1934, **18**, 449.

The Emission of Fast Particles.

As a result of a series of experiments recently carried out by Rutherford and others,[1,2] it has been shown that from a number of radioactive elements groups of fast particles are often emitted. Moreover the elements which are supposed to emit particles of given velocity really give out particles of velocities varying over a small range. Accordingly the wavestatistical formula deduced before[3] must be modified.

From a numerical computation of the energy of the disintegrated α-particles, it can be shown that they become free at least at a distance $10^{-13} \rightarrow 10^{-12}$ cm., from the centre of the core. On the other hand the wavestatistical formula of the radius of the hard core gives $r_0 \sim 10^{-15}$ cm., for radioactive substances. So we have to suppose that the region between 10^{-15} and 10^{-13} cm. is filled with electrically neutral particles. Evidently it corresponds to the neutral shell of Rutherford. Since it is outside the charged core, the electrical force of repulsion is Coulombian in this region.

According to Rutherford the shell is filled with polarised helium atoms. But it appears a more general assumption would be to suppose that the shell is packed with large numbers of α- and β-particles, such that the net charge is zero. The particles may possibly circulate in a number of orbits under a polarisation field. Thus the neutral shell may be supposed to consist of a number of thin shells of particles. Now as soon as an α-particle comes out of the core and passes through the shell, it will naturally interact with the circulating α-particles in the thin shells. And as a result of that an α-particle which was originally present in the shell is ejected.

It is evident that the rate of disintegration is really the rate of ejection from the thin shells. The previous wavestatistical formula gives the rate at which the α-particles enter the shell from the hard core within. Multiplying this rate by the number of α-particles present in an excited state in a given thin shell, we find for the disintegration constant:

$$\lambda = \text{const.} \frac{\sqrt{U_0 E}}{\text{Cot} u_0} \cdot e^{-2k(2u_0 - \sin 2u_0)} \sin^2 \frac{2\pi m v r_1}{h}$$

where the symbols have been explained in the previous paper.[4,5]

If it is supposed that the α-particles belonging to a particular group are all emitted with the mean velocity, then the factor $\sin^2 \frac{2\pi m v_1}{r_1}$ becomes evidently unity,

and the above reduces to the older wave-statistical formula.

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Calcutta,
August 26, 1935.

[1] Rutherford, Ward and Lewis, *Proc. Roy. Soc.*, 1931, **131**, 684.
[2] Rutherford, Wynn-Williams and Lewis, *Proc. Roy. Soc.*, 1931, **133**, 351.
[3] K. C. Kar and A. Ganguli, *Phil. Mag.*, 1933, **16**, 1097.
[4] Kar and Ganguli, *loc. cit.*
[5] Kar and Ganguli, *Curr. Sci.*, 1934, **2**, 387.

Rolf's Graphs to Sommerfeld's Attenuation Formula.

NORTON[1] has recently pointed out an error in Rolf's[2] calculations of flat-ground attenuation of wireless waves according to Sommerfeld's theory.[3] Since Rolf's graphs have been extensively employed in connection with experimental investigations on ground-attenuation, it is necessary to test how far this error would vitiate the attenuation curves drawn by Rolf.

Setting right the error, Norton has given the following empirical formula for the attenuation factor S for small values of b:

$$S = f(p_0) - \sin b \, \frac{\sqrt{p_0}}{2} \, e^{-\frac{5}{8}p_0}$$

where p_0 is Sommerfeld's "numerical distance" and is equal to $q/2$ of Rolf. The quantities b and q are defined by

$$\tan b = \frac{\epsilon + 1}{6\lambda\sigma} \cdot 10^{-15} \text{ and } q = \frac{2\pi \sin b}{(\epsilon+1)\lambda} \cdot r$$

where σ (expressed in e.m.u.) is the electrical conductivity, ϵ (expressed in e.s.u.) the dielectric constant of the ground, λ the wavelength (in km.) and r the actual distance in km. from the transmitter. The first term $f(p_0)$ in Norton's expression for the attenuation factor can be calculated from Van der Pol's empirical formula:

$$S = f(p_0) = \frac{2 + \cdot 3p_0}{2 + p_0 + \cdot 6p_0^2}$$

(This formula is free from the error pointed out by Norton.)

In Table I we have compared the values of attenuation factor for different values of q obtained from Rolf for (1) $b = 5°$ and (2) $b = 0°$ with those calculated from Norton's formula. The values of attenuation according to Van der Pol are also given in the table.

TABLE I.

b	q	Attenuation Factor		
		Rolf	Pol	Norton
5°	3·0	·59	·50	·47
	2·0	·70	·64	·61
	1·0	·85	·81	·78
	0·2	·97	·95	·93
0°	3·1	·5	·49	·49
	2·3	·6	·62	·62
	1·7	·7	·69	·69
	1·0	·8	·81	·81
	0·4	·9	·92	·92

Rolf's values for $b = 5°$ are slightly higher than those calculated from Pol and Norton. There is better agreement when the values of q are very small. The agreement is perfect for $b = 0$. It should be remembered that Van der Pol's formula is valid only when $\sigma > \frac{2\pi c \epsilon}{\lambda}$. A little calculation will show that for this condition to hold, b should be less than 5°. It is therefore expected that for b greater than 5°, the values of attenuation calculated according to Pol will be discrepant.

We can therefore say that so far as we can test Rolf's attenuation curves *within the range of validity of the empirical formulæ*, the error pointed out by Norton does not appear to materially alter these curves at least for very short distances from the transmitter.

Whether the peculiar features in Rolf's graphs, *viz.*, the negative attenuation and the 'dips', exist according to Sommerfeld's theory cannot, however, be ascertained from Norton's formula. Fresh mathematical investigation is necessary to test these points.

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Physical Laboratory,
Dacca University,
August 19, 1935.

[1] Norton, *Nature*, June 8, 1935, **135**, 955.
[2] Rolf, *Proc. I. R. E.*, March 1930, **18**, Part I.
[3] Sommerfeld, *Ann. der Physik.*, 1909, **4**, 28, 665; *Ann. der. Physik.*, 1926, **81**, 1135.

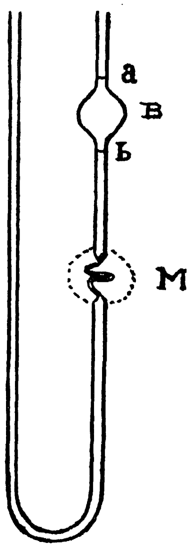
Influence of Magnetic Field on the Coefficient of Viscosity of Liquids.

In view of the fact that Raha and Chattarjee[1] have recently published a paper on the influence of magnetic field on the coefficient of viscosity of liquids, it may be of interest to record an earlier attempt of mine, in 1932, in which a similar study was undertaken by a different method. The observed variation in the coefficient of viscosity due to the magnetic field being much less than 0·5 per cent., the results of the experiment were considered to be indecisive. The method employed and the results obtained were however included in my M.Sc. thesis, submitted in 1933 to the Mysore University, as an appendix, which runs as follows:

"*Viscosity measurements in a magnetic field.* In order to formulate a theory of viscosity of liquids and to derive an expression for its temperature coefficient Andrade[2] has made the assumption that the viscous force between layers in relative motion is due to transitory binding between molecules in the two layers. G. W. Stewart[3] has supported Andrade's view making use of the information derived from X-ray diffraction of liquids. His work has revealed the existence of constantly fluctuating 'liquid crystalline groups', which are due to molecular field in liquids. Hence the force between successive layers in relative motion is due to 'transitory and fluctuating crystallisation of liquid molecules'.

"Since molecules and molecular groups of several substances, especially those of aromatic compounds, have been found to possess magnetic anisotropy, they might be expected to experience a preferential orientation in a magnetic field, so far as thermal agitation allows them to do so. With a view to test if such an orientation affects the force between successive layers in relative motion and thus alter its coefficient of viscosity, measurements were carried on benzene by comparing the time of flow of the liquid through a constriction in a viscometer, when a magnetic field was acting at the constriction with that when it was not.

"The viscometer employed is shown in the figure and the constriction was a narrow capillary bent as shown in the figure. This was designed to suit the measurement in a magnetic field and was blown out of pyrex glass. The viscometer is so placed that the constriction lies in the narrow space between the poles of a Dubois magnet. In order that the tractive force might not affect the rate of flow of the liquid, care was taken to see that the bulb B was well above the pole pieces. The zig-zag path of the capillary keeps the liquid for a long time in the field. Liquid was sucked until the bulb B and the tube above it were filled with the liquid. When the liquid began to flow down the times taken by the liquid to travel from the mark *a* to *b* were noted both when the magnetising current was on and off, a number of times. The total time taken for the flow was 3 minutes and 15 seconds and in a few observations with the field on it came out as 3 minutes 14 seconds; but in other cases it was equal to the value in the absence of the field. It is inferred therefore that the magnetic field has no appreciable influence on the viscosity of a liquid. This might be due to a small fraction of the liquid molecules orienting themselves in the magnetic field. G. W. Stewart[4] has observed that appreciable orientation occurs in the milky state, very near the melting point (116° C.), in the case of para-azoxyasinol and that this orientation becomes almost negligible when the temperature of clearing (134° C.) is passed. An attempt will be made to conduct the above experiment having liquids at a few degrees above their melting points."



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August 21, 1935.

[1] *Ind. Jour. Phys.*, 1935, **9**, 415–454.

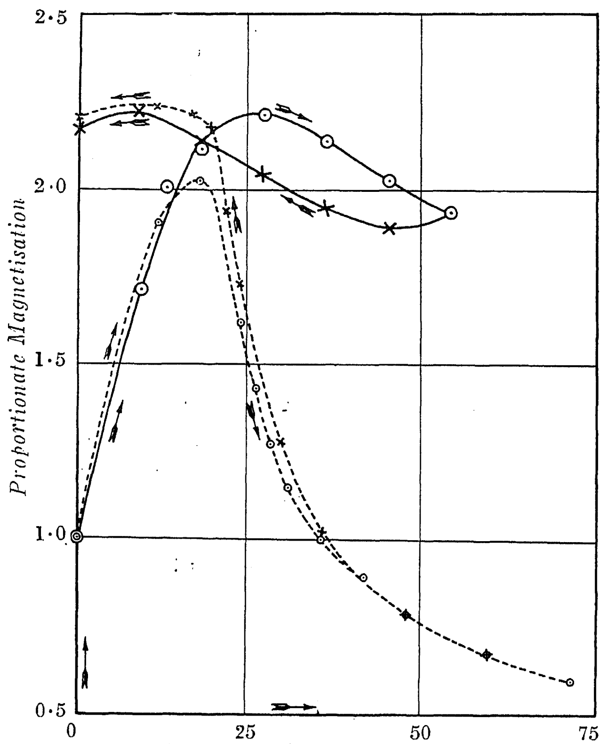
[2] *Nature*, 1930, **125**, 582.

[3] *Nature*, 1931, **125**, 727.

[4] *Phys. Rev.*, 1931, **38**, 931–942.

The Phenomenon of Negative Hysteresis in Nickel.

PROCOPIU[1] has studied the influence of an alternating circular or longitudinal field on the intensity of magnetisation of Iron and Steel in a constant magnetising field. The work has been extended to the case of Soft Iron and Nickel. The specimens in the form of wires were first put to a few complete magnetisation cycles in zero alternating field, and ultimately left in a weak magnetic field, so that the magnetisation had a small positive value. The alternating field was then gradually increased to a convenient value and then decreased subsequently. The longitudinal field was produced by passing an alternating current through a solenoid surrounding the specimen, and the circular alternating field, by passing an alternate current through the substance itself. The results for nickel are given in Fig. 1. The circular



— Circular Alternating Field (Constant Magnetic Field—19·30G).
---- Longitudinal Alternating Field (Constant Magnetic Field—19·54G).

alternating field refers to the field at the periphery of the wire and was calculated according to the formula $H = \frac{2I}{10r}$, where 'I' is the strength of the alternating current, and 'r' the radius of the specimen.

The result in the case of Soft Iron is essentially the same as Procopiu's, with the difference that a slight hysteresis is noticeable even in the descending part of the curve, which was absent in Procopiu's work. In the case of Nickel in alternating longitudinal field, the effect is similar in nature to that in the case of Iron, but in the alternating circular field, the behaviour of Nickel is anomalous. The curve for decreasing alternating field goes below that for the increasing field and a loop is formed between the two curves, thus showing Negative hysteresis.

A similar effect of Negative hysteresis has been noticed by several workers[2] in the Magneto-Resistance change of Nickel and has been ascribed by Stierstadt[3] to the previous magnetic treatment of the specimen, but its exact nature has not been understood as yet. It is significant that this Negative hysteresis appears only when a current passes through Nickel, as in the case of the alternating circular field and not in the case of the alternating longitudinal field, where no alternating current passes through the specimen. The occurrence of the effect in the Magneto-Resistance change, where again a current passes through the specimen, suggests that Negative hysteresis is connected with some aspect of the movement of conductivity electrons. The effect is no doubt real and an intensive study of the phenomenon is required for throwing light on this anomalous behaviour of Nickel.

The experiment was performed in the Physics Laboratory of the Patna Science College and my best thanks are due to the authorities for kind permission, specially to Prof. K. Prosad, I.E.S., for his constant interest in the work. I also wish to thank Dr. M. M. Sen Gupta, Senior Professor of Physics, Ravenshaw College, Cuttack, for helpful discussions.

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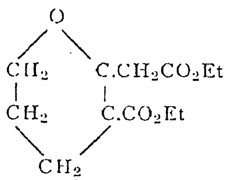
September, 1935.

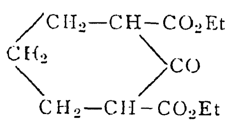
[1] S. Procopiu, *J. de Physique et le Radium*, 1930, **1**, 365-72.
[2] Fr. Vilbig, *Arch. f. Electrotechnik*, 1929, **22**, 194; Sen Gupta and Alam, *Ind. Jour. Phys.*, (8) **33**, p. 9.
[3] O. Stierstadt, *Phys. Rev.*, 1931, (2) **37**, 1356.

Action of Trimethylene Bromide on Acetonedicarboxylic Ester: A New and More Convenient Method of Synthesis of Ethyl *Cyclo*-hexane-2 : 6-Dicarboxylate.

PERKIN[1] obtained ethyl methyldehydrohexonedicarboxylate (I) by the action of trimethylene bromide upon Na-derivative of ethyl acetonedicarboxylate in alcoholic medium; the corresponding di-acid, m.p. 185°–92°, and the mono-acid mono-ester, m.p. 115°. The reaction was tried in dry benzene suspension by heating for nearly 100 hours at 140°–50° in sealed soda water bottles with the expectation that ethyl *cyclo*-hexanone-2 : 6-dicarboxylate, if formed under these conditions, would furnish a convenient starting material for the study of some 1 : 3-bridge formation in the *cyclo*hexane molecule. The reaction mixture was separated into two portions—petrol soluble and petrol insoluble. The former, about half of the whole in quantity, gave a liquid, b.p. 142°/2 mm. along with some unreacted ester and ethyl acetoacetate. The ester, b.p. 142°/2 mm. gave on hydrolysis a dibasic acid, m.p. 172°, and a mono-acid mono-ester, m.p. 83°, agreeing in composition with Perkin's compounds, which are isomeric with ethyl *cyclo*hexanone-2 : 6-dicarboxylate and its derivatives. From the petrol insoluble portion, the phenolic lactone, m.p. 188° [2] was isolated amongst other products not identified.



(I)



(II)

Having found the reaction of sodium or sodium ethoxide, upon acetone dicarboxylic ester is always attended with the formation of phenolic bodies and according to Perkin of compounds containing oxygen in the ring, it was considered desirable to try a milder metallic derivative. Trimethylene bromide reacts with the magnesium derivative of acetone dicarboxylic ester to yield the expected ethyl *cyclo*hexanone-2 : 6-dicarboxylate (II) b.p. 144°/3 mm.; phenyl hydrazone, m.p. 150°, mixed m.p. with a genuine sample remaining undepressed. This new method is more convenient to work with and the yield compares favourably with that obtained by the older method.

This new observation as also the formation of a suberone derivative[3] and of a *cyclo*-pentanone derivative[4] from Na-derivative of acetone dicarboxylic ester establish definitely that under suitable conditions it can react in the ketonic form lending itself to the formation of homocyclic compounds and not only in the enolic form as observed by Perkin.

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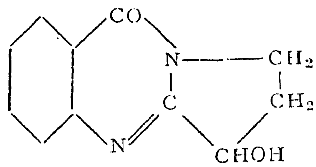
N. K. SESHADRIENGAR.
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
September, 1935.

[1] *J. C. S.*, 1887, **51**, 739.
[2] Jerdan, *J. C. S.*, 1887, **71**, 1106.
[3] Braun, *Ber.*, 1913, **46**, 1792.
[4] Ingold, *J. C. S.*, 1928, p. 365.

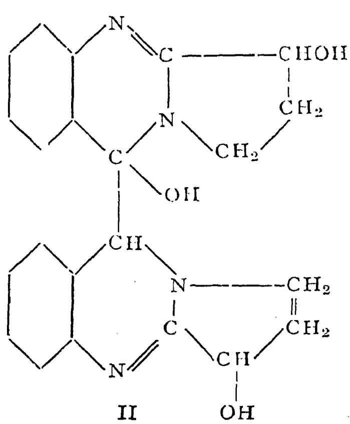
The Oxidation Products of Vasicine with Hydrogen Peroxide.

MORRIS, HANFORD AND ADAMS[1] have found that vasicine does not react with 3% H_2O_2 as stated by Ghose[2] *et al* but does so with 30% H_2O_2 and on interaction at 60°–70° it gives a compound m.p. 214° as stated by Ghose *et al.* To this compound, they have assigned the structure (I).



I

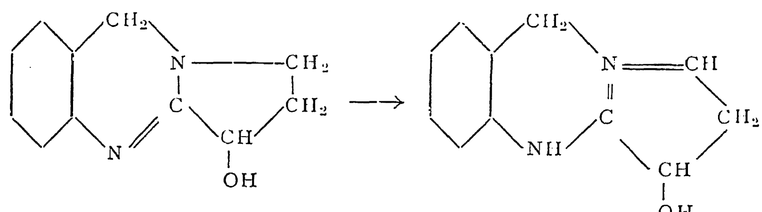
But a second product m.p. 168° obtained by Ghose *et al* was not found and they are of opinion that it was an equi-molecular mixture of I and vasicine.



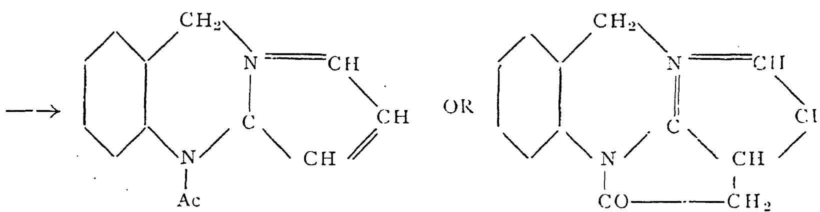
II

The strength of hydrogen peroxide stated by us to be 3% was a typographical error for 30%. Repeated experiments have invariably yielded the substance m.p. 168° and the constant analytical values obtained after crystallisation justify the view that it cannot be a mixture. Under the microscope the substance has a homogeneous appearance. Its formula was given by Ghose *et al* as $C_{11}H_{10}NO$; $\frac{1}{2}H_2O$. It is probably $2(C_{11}H_{10}NO; \frac{1}{2} H_2O)$, *i.e.*, $C_{22}H_{22}N_2O_3$ and its structure represented by II as it is almost quantitatively oxidised by H_2O_2 to I.

The acetyl derivative of vasicine was obtained as an oil by Spath, contrary to Ghose *et al* who record a m.p. 164°. It was this discrepancy which at one time suggested the possibility of vasicine being different from peganine. It is gratifying to note that Spath, Kuffner and Platzer[3] now find the m.p. to be 163–164°·5 in confirmation of Ghose *et al*. Its structure can be represented as below :

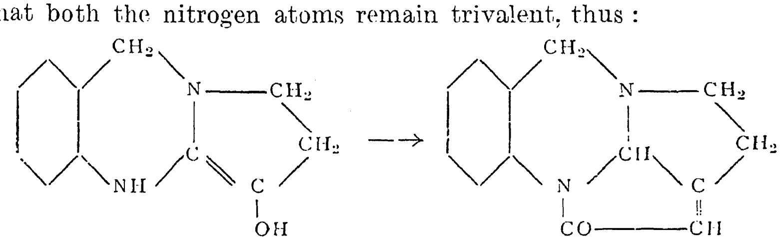


Vasicine Iso-Vasicine



It is more probable that both the nitrogen atoms remain trivalent, thus :

Vasicine →



Iso-Vasicine

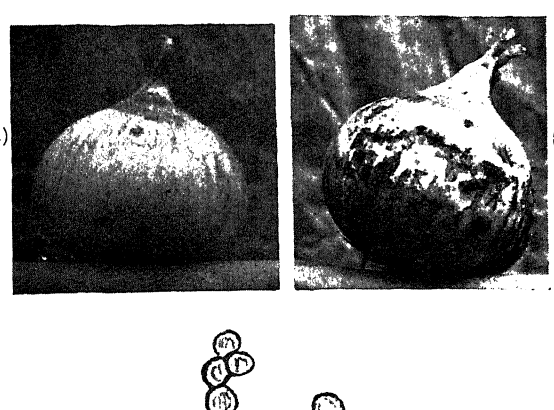
T. P. GHOSE.
S. KRISHNA.
K. S. NARANG.
J. N. RAY.

University Chemical Laboratories, Lahore,
September 6, 1935.

[1] *J. Am. Chem. Soc.*, 1935, **57**, 954.
[2] *British Chem. Abstracts*, 1933, **A 1**, 77.
[3] *Ber.*, 1935, **68**, 935.

Storage-Rot of Onions.

IN 1932 the attention of the senior writer was attracted towards this serious disease, which caused a waste of more than half to his onion-store. Although exceedingly common, no mention about it is found in Butler's *Fungi and Disease in Plants* (1918), *The List of Specimens in the Mycological Herbarium, Pusa* (1921), *The Fungi of India, Calcutta* (1931), *The Fungi of Bombay* (1935). The causal agent, an *Aspergillus* sp. in spite of



(a) (b) (c)

Baroda White Onions: (*a*) healthy, (*b*) diseased, (*c*) spores of the malady through oil immersion.

its existence in the soil, has never been found to be parasitic on the living plant. It attacks only the mature bulbs. Observations taken on different modes of storage showed the decay in (1) heaps 47·5%, (2) one layer spread on rice straw 14·6%, (3) store in well-ventilated hanging baskets 15%, and lastly (4) four to five onions woven together by their leaves and hung on a string 15%. Isolated cultures of the organism showed best growth at 34°–35° C. in the multiple incubator.

Walker and Murphy[1] have described an identical rot on onions and garlics imported in the States from Italy. *Botrytis Allii*, Munn. has been long known as Neck Rot of onions both in America and Europe and is seen to attack the inflorescence. The Indian organism seems to differ specifically from the *Aspergillus* described from America. Further observations as to the mode of attack of the organism, its physiology and its response to different methods of storage and chemical treatments are continued.

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G. H. DESAI.

Research Laboratory,
Agricultural Experimental Station,
Baroda,
August, 1935.

[1] *Phytopathology*, March 1934.

A Somewhat Cosmopolitan Parasite—*Loranthus longiflorus*.

WITH reference to the article by Mr. Srivastava[1] we wish to point out that at least in Hyderabad the occurrence of *Loranthus longiflorus* on the following host-plants, many of which to our knowledge at least have not been mentioned by previous writers, has long been recorded, but the publication was detained in order to find out as many hosts as possible of this parasite. Mr. Srivastava mentions two of the new hosts which we have recorded.

1. *Psidium guayava.*
2. *Melia azadirachta.*
3. *Cordia myxa.*
4. *Anona squamosa.*
5. *Punica granatum.*
6. *Tamarindus indica* (very rarely).
7. *Citrus aurantium.*
8. *Millingtonia hortensis.*

As has been mentioned by other writers *Loranthus* is a branch parasite and flowers profusely about the months of June and July. The following hosts of *Loranthus longiflorus* are mentioned by different writers. *Bassia latifolia* and *Diospyros Melanoxylon* are recorded by Partridge.[2] Cooke[3] states that it is common on mango trees in Bombay and throughout the Konkan. Duthie[4] mentions that it is parasitic especially on mango, neem and mahua. Hooker[5] mentions nothing about the host-plants of *Loranthus*. Keeble[6] gives a beautiful account of the *Loranthaceæ* of Ceylon describing in detail the fertilization of the flower, mode of distribution of seeds, etc., but does not mention the hosts. Although this parasite is becoming somewhat cosmopolitan it is worth while recording from time to time in different localities on what new hosts it spreads. Evidently there does not seem to be any specialisation of hosts in this parasite.

Nectar fills the corolla-tube in *Loranthus longiflorus*. In addition to this Keeble mentions that " a drop is lodged behind the base of each filament between it and the corolla-lobes". It attracts small insects and birds. The latter seem to be the chief fertilizing agents. Their gentle tap breaks open the corolla-lobes which were hitherto closed. Keeble suggests that " this remaining closed of the ripe flowers is an instance of close relationship, beneficial to both parties, between flower and fertilizer; the bird knows it is worth its while to 'tap a new barrel' as it were; moreover, the parts of the flower are protected from the damaging effects of exposure to wet." It is so indeed. In the majority of the *Loranthaceæ* the seeds are dispersed by the agency of birds and in some cases by the explosions of the fruits as Dr. B. Sahni[7] states. Engler and Prantl[8] in their account of the distribution of the seeds conclude by saying that " The stickiness (of the viscin) enables some seeds, falling from branch to branch, to become attached; on the other hand, birds bite up the fruits and throw away the seed which is surrounded by the viscid layer " and further that seeds often pass unharmed through the gut of birds and may then germinate. Our own observations confirm much of what has been quoted. It is a very common observation that according to the nature of the fruit-coat and the seed that birds reject the former or the latter. In the case of the fruit-coat of *Loranthus* we know that it contains a lot of tannin, and hence it does not appeal to the birds which extract the seed with the pulp from the fruit and reject the coat.

FIG. 1. *Loranthus longiflorus* (Loranthaceæ) parasite on *Melia azadirachta* (Meliaceæ).

FIG. 2. *Loranthus longiflorus* (Loranthaceæ) parasite on *Cordia myxa* (Boragineæ).

Although the birds eat away the pulp and get rid of the seeds by wiping or stricking their beaks against branches or other objects, occasionally some of them are swallowed. Out of these a few pass unharmed through the gut and germinate quite well while others are destroyed by the digestive juices in the gut. However, this fact is an established one that birds are responsible for the dissemination of seeds in *Loranthus*.

As a result of the attack of *Loranthus* on its hosts, outgrowths of considerable size and peculiar complicated shape result. Ultimately the host becomes almost brittle and falls down. Further observations are being made.

M. SAYEED-UD-DIN.
M. A. SALAM.

Osmania University,
Hyderabad, Deccan,
September, 1935.

[1] Srivastava, G. D., *Curr. Sci.*, 1935, **4**, 106.
[2] Partridge, E. A., *Forest Flora of Hyderabad*, 1911, 343.
[3] Cooke, T., *Flora of the Bombay Presidency*, 1903-08, **2**.
[4] Duthie, J. F., *Flora of the Upper Gangetic Plain*, 1903-20, **2**.
[5] Hooker, J. D., *Flora of British India*, 1875-79, **4**.
[6] Keeble, F. W., *Trans. Linn. Soc.*, 1896, S **2**, Pt. 3.
[7] Sahni, *Jour. Ind. Bot. Soc.*, 1933, **12**, 2, 96.
[8] Engler and Prantl, *Die Naturlichen Pflanzenfamilien*, Teil **3**.

Double Parasitism of *Loranthus* and *Viscum* on Eugenia.

Loranthus is a very common parasite of flowering plant all over Western India. It has numerous hosts which include a number of cultivated plants. The species *longiflorus* is the commonest and is found very extensively both on cultivated and wild plants. *Viscum*, on the other hand, is less common and is usually found in thick forests and in shady places. I have never seen *Loranthus* parasitic on Myrtaceæ but a case has recently been reported by Mr. G. D. Srivastava[1]. I am therefore inclined to record another case of a similar kind but still more interesting. In July last I observed a *Loranthus* parasitic on a tall plant of *Eugenia jambolana* and when the specimen was collected I discovered that it has itself been parasitised by *Viscum articulatum*, the *Loranthus* being a parasite directly on Eugenia.

The parasitism of *Loranthus* on Myrtaceæ is certainly rare but such a case of *Viscum* on *Loranthus* and *Loranthus* on *Eugenia jambolana* is certainly very rare and is worth recording. Perhaps such double parasitism is seen in the deeper forests of the Thana District where this plant was found, but I know of no record of the kind.

MOSES EZEKIEL.

Biology Department,
Wilson College, Bombay.
September 4, 1935.

[1] *Curr. Sci.*, 1935, **4**, 106.

N.B.—Since writing the above I saw in the Victoria Gardens, Bombay, *Loranthus longiflorus* parasitic on *Callistemon linearis* (*C. coccinia*, the Australian Bottle Brush), a member of the family Myrtaceæ. This fact is worth noting because *Callistemon* is an introduced garden plant, and more so because this garden is remarkably free from *Loranthus* parasites, this case being one of the very few in the garden.

September 9th, 1935. M. EZEKIEL.

Chromosome Numbers in Two Species of *Hibiscus* (*H. sabdariffa* L. and *H. cannabinus* L).*

THE genus *Hibiscus* belongs to the fairly big family of Malvaceæ which includes a great many familiar plants of cultivation, notably cotton. Cytological work on this economically important family is receiving greater attention in recent times and the work of Davie (1934)[1] gives a comprehensive survey of results obtained. While the cytology of the genus *Gossypium* has been worked out in some detail by several authors that of other genera has not received so much attention. In the genus *Hibiscus* itself only nine species have been examined for their chromosome numbers which reveals polyploidy with high chromosome numbers. The author, while at Pusa, examined cytologically two other species, namely *H. sabdariffa* and *H. cannabinus* for their chromosome numbers and the results are embodied in this note.

Root tips of a pure line of *H. cannabinus* and several varieties of *H. sabdariffa* were fixed in Allen's modification of Bouin's fluids at different times of the day and after the usual dehydration, clearing, and embedding, cut into sections from 10-12μ thick and stained with Haidenhain's Hæmatoxylin. Drawings were made with the aid of a camera lucida at a magnification of 2500. It was found that under conditions obtaining at Pusa, cell divisions started as early as 10 A.M. and continued till 3 P.M. with a maximum phase in the middle, after which there was a cessation and a renewed activity

(*Continued on p.* 175.)

SUPPLEMENT TO "CURRENT SCIENCE".

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Norwich, 1935.

The Presidential Address.

Form, Drift and Rhythm of the Continents.

By Professor W. W. Watts, LL.D., SC.D., F.R.S.,
President of the Association.

IT is now sixty-seven years since the British Association enjoyed the hospitality of the city of Norwich, a privilege which is being renewed to-day under the most happy auspices.

At that meeting we find the scientific community was particularly interested in underground temperatures and tidal phenomena, in the application of the spectroscope to celestial objects, and in the discovery of the oldest Cambrian fossils and the earliest fossil mammals then known. Many papers were read on local natural history, including those on Norfolk farming and the drainage of the County and of the Fens.

In his address at the meeting the President, Sir Joseph D. Hooker, made special reference to the work of Charles Darwin: not to the *Origin of Species* which had been acrimoniously discussed by the Association on previous occasions, and notably at Oxford in 1860, but to some of the work that followed.

It should be remembered that Hooker was one of the three scientific men, representing botany, zoology and geology, whom Darwin had selected as judges with whose opinion on the soundness of his theory of the origin of species he would be content. The others were Huxley and Lyell; and of the three Lyell was the hardest to convince, chiefly because the record of life in the past then furnished by the rocks was manifestly so incomplete and unsatisfactory that its evidence was insufficient to warrant a definite verdict.

Lyell had set out to 'treat of such features of the economy of existing nature, animate and inanimate, as are illustrative of geology,' and to make 'an investigation of the permanent effects of causes now in action which may serve as records to after ages of the present condition of the earth and its inhabitants.' By laborious study of the work of others, and by his own extensive travel and research, he had been able to enunciate, for the inorganic world, the principle of uniformitarianism, which in its original form we owe to Hutton. This principle involved that the history revealed by the rocks should be read as the effect of the slow but continuous operation of causes, most of them small, such as could be seen in action in some part or other of the world to-day. This was set in opposition to the opinion of the older geologists who had postulated a succession of catastrophes which, by flood, fire and convulsion, had periodically wrecked the world and destroyed its inhabitants: each catastrophe necessitating a new creation to provide the succession of life on the earth as it then was known.

But in the organic world Lyell, like Hutton, had failed to detect any analogous principle, and, as he rejected all the theories of transmutation of species then in vogue, he had to accept their absolute fixity; and to suppose that, as species became extinct one after another, replacement by special creations followed. And yet the reading to-day of the chapters devoted to this branch in the earlier editions of Lyell's great work produces the haunting feeling that a better explanation had only just eluded him. It was the story revealed in Lyell's work, Darwin tells us, the new conception that the earth had been in existence for vast æons of time, the proof that it has been continuously peopled by animals and plants, and that these had steadfastly advanced and improved throughout that time, which showed him the necessity for an explanation of the progression of life, and gave him the first hints of his theory. When he had enunciated this he was enabled to repay his master with the principle of organic evolution, which brought changes in the animate world into harmony with those of the inanimate.

His *Antiquity of Man* shows that by

1863 Lyell had become a convert, and he afterwards rewrote much of the second volume of his *Principles* accepting the new point of view. This change earned from Hooker a testimonial in the 1868 address which, if not unique, must certainly be one of the most magnificent ever awarded to a scientific work:

> 'I know no brighter example of heroism, of its kind, than this, of an author thus abandoning, late in life, a theory which he had regarded as one of the foundation stones of a work that had given him the highest position attainable amongst contemporary scientific writers. Well may he be proud of a superstructure, raised on the foundation of an insecure doctrine, when he finds that he can underpin it and substitute a new foundation: and, after all is finished, survey his edifice, not only more secure, but more harmonious in proportions than before.'

Although infinitely richer than when Darwin wrote, the Geological Record still is, and must from its very nature remain, imperfect. Every major group of animal life but the vertebrates is represented in the Cambrian fauna, and the scant relics that have been recovered from earlier rocks give very little idea of what had gone before, and no evidence whatever as to the beginnings of life.

But, from Cambrian time onward the chain of life is continuous and unbroken. Type after type has arisen, flourished and attained dominion. Some of them have met extinction in the heyday of their development; others have slowly dwindled away; others, again, have not finished their downhill journey, or are still advancing to their climax.

Study of the succession of rocks and the organisms contained in them, in every case in which evidence is sufficiently abundant and particularly among the vertebrates and in the later stages of geological history, has now revealed that the great majority of species show close affinities with those which preceded and with those which followed them; that, indeed, they have been derived from their predecessors and gave origin to their successors. We may now fairly claim that palæontology has lifted the theory of evolution of organisms from the limbo of hypothesis into a fact completely demonstrated by the integral chain of life which links the animals and plants of to-day with the earliest of their forerunners of the most remote past.

Further, the rocks themselves yield proof of the geographical changes undergone by the earth during its physical history; and indicate with perfect clearness that these changes have been so closely attendant on variation in life, and the incoming of new species, that it is impossible to deny a relation of cause and effect.

Indeed, when we realise the delicate adjustment of all life to the four elements of the ancients which environ it, air, water, earth and fire; to their composition, interrelationships and circulation; it is perhaps one of the most remarkable facts established by geology that, in spite of the physical changes which we know to have occurred, the chain of life has never snapped in all the hundreds of millions of years through which its history has been traced.

The physical changes with which Lyell and his successors were most closely concerned were, firstly, the formation of stratified rocks on horizontal sea-floors, situated in what is now often the interior of continents, far removed from the oceans of the present day, and thus indicating important and repeated changes in the position of land and water; and, secondly, the deformation of these flat deposits till they were rucked and ridged to build the mountain ranges.

Before and since Lyell's time geologists have devoted themselves to working out the exact and detailed succession of these stratified rocks, translating their sequence into history and their characters into terms of geography; the succession of physical conditions prevailing at the time of their formation. Further, although animals and plants migrate from place to place, the time occupied by the migrations of suitable forms is so negligible when compared with the length of the chapters of geological history that their fossil remains have proved to be the best means for correlating strata over broad stretches of the earth's surface. This correlation has converted the fragments of local history thus revealed into at least the outlines of the geological story of the world.

It was not till 1885, however, that the accumulation of data of this type was sufficient to enable the great geologist, Suess, an Austrian but born in this country, to assemble and correlate them, and to deduce from them further principles which have been the mainstay and inspiration of his successors. We owe to Hertha Sollas and her father the rendering of this great work, *The Face of the Earth*, into English; and to Emmanuel de Margerie and his colleagues a French translation enriched

with a magnificent series of maps and sections such as could only have been brought together by one with the most remarkable bibliographic knowledge; a veritable recension of the original.

The nature and associations and the distribution in time and space of modern changes in the relative levels of land and sea, as detected at sea-margins and by altitude survey, and of older changes betrayed by such evidence as submerged forests and raised beaches, had convinced geologists that the unstable element was not the fickle and mobile sea, but the solid if elastic earth-crust. They naturally applied the same explanation to those encroachments of the sea in the past which had resulted in the formation of our stratified rocks. But while some investigators were content with one form of movement—that due to lateral pressure—to explain both the formation of mountains and the rise and fall of the land, others called in a different cause for the latter. Without entering into a discussion of causes it may be well for us to distinguish the orogenic or mountain-forming from the epeirogenic or continental movement.

The evidence collected by Suess proved that these last great land and sea changes had occurred simultaneously over whole continents or even wider regions. Such great submergences as those to which the Cambrian Rocks, the Oxford Clay and the Chalk are due were of this character; while, in between, there came times of broad expansions of continental land and regressions of the sea. These changes were in his view on far too grand a scale to be compared with, or explained by, the trivial upheavals and depressions of land margins of the present day, which he showed could mostly be correlated with volcanoes or earthquakes, or with such incidents as the imposition or relief of ice-sheets on an elastic crust in connexion with glacial conditions.

It became necessary for him to replace or supplement oscillations of the earth-crust by a world-wide periodic ebb and flow of the oceans, to and from the continents; positive movements of transgression carrying the sea and its deposits over the lands, drowning them and their features under tens or hundreds of fathoms of water; and negative movements or regressions when the oceans retreated to the deeps, leaving the continents bare or encrusted with recently formed sediments.

Although the facts cried out for this generalisation Suess was at a loss to supply any mechanism competent to produce the wonderful rhythm. The problem was difficult because a liquid must maintain a horizontal, *i.e.*, an equipotential, surface. It was manifestly impossible to withdraw from the earth, and later to replace upon it, the vast quantity of water that would be required; and, though a shifted water-level, or even a varied water-surface relative to the continents, might be caused by polar ice-caps, by redistribution of the continents carrying their local effects on gravitation, by variations in the rate of the earth's rotation, or other far-reaching causes, none of these would supply an explanation that fitted all the facts. Regressions of the sea could be to some extent explained if Suess's main postulate, that the great ocean basins had been slowly sinking throughout geological time, were granted. But this explanation only rendered more impotent the raising of ocean levels by deposits of sediment, and this was almost the only valid cause for transgressions that he had been able to suggest.

Further, it is not possible to ignore the definite relationship that exists between the pulsation of the oceans and the raising of mountains by lateral or tangential stress. Periods of positive movement or advance of the seas were times of comparative tranquillity, when tangential pressure was in abeyance. Periods of negative movement and retreat were invariably marked by the operation of great stresses by which the earth's face was ridged and wrinkled in the throes of mountain-birth.

The theory that continuous cooling and shrinkage of the interior of the earth afforded an explanation of mountain ranges and other rugosities on its surface was a legacy from the nebular hypothesis. In spite of the homely simile of a shrivelling apple, this explanation has never received a very enthusiastic welcome from geologists, though, in default of other resources, they had to make use of it. As knowledge has grown the difficulties have become insurmountable to them.

First, there is its inadequacy to explain the vast amount of lateral movement required to account for the greater mountain ranges; their rocks, originally spread over a wider area, having been folded and crushed into a narrower width. The shortening of the earth-crust thus effected has been estimated in the case of the Rocky Mountains at 29

miles, of the Himalayas at 62, the Alps at 76, and the Appalachians at the large figure of 200 miles.

Then there is the periodicity of mountain growth. The great epochs of mountain-building, such as the Caledonian, to which the chief Scottish and Welsh mountains are due, the Hercinian, responsible for the Pennine and South Wales, and the Alpine, which gave us 'the wooded, dim, blue goodness of the Weald,' were associated with vast continental development; and each was separated from the next by a period of relative inactivity lasting dozens of millions of years.

Further, there is the fact that the vigour of mountain-building, of volcanoes, and of other manifestations of unrest, has shown no sign of senility or lack of energy. The geologically recent Alpine-Himalayan range is as great, as lofty, and as complicated in structure, as were any of its precursors. The active volcanoes of Kilauea, Krakatao, or St. Pierre, and those recently extinct in Northern Ireland and the Scottish Isles, were as violent and efficient as any of those of the Palæozoic Era. The earth is 'a lady of a certain age,' but she has contrived to preserve her youth and energy as well as her beauty.

But it was when Lord Kelvin's dictum struck from geology its grandest conception, time, that it became vital to re-examine the position. He had demonstrated that, if the earth had been continuously cooling down at its present rate, its surface must have been too hot for the existence of life upon it a limited number of million years ago. The concept of geological time, indicated by Hutton in his famous saying that in this enquiry 'we find no vestige of a beginning —no prospect of an end,' had been confirmed by data accumulated through the painstaking researches of a host of competent and devoted observers all over the world. To them, familiar with the tremendous changes, organic and inorganic, that the earth had passed through since Cambrian time, it was wholly impossible to compress the life story of the earth, or the history of life upon it, into a paltry 20 or 30 million years. The slow growth and slow decay of mountain range after mountain range, each built out of, and in some cases upon, the ruins of its predecessor; the chain of slowly evolving organisms, vast in numbers and infinite in variety; told plainly of long æons of time. And the duration of these æons can be dimly realised when it is recalled that, within a small fraction of the latest of them, man, with the most primitive of implements and the most rudimentary culture, has succeeded in penetrating to the uttermost corners of the world, and developed his innumerable languages and civilisations.

Huxley, as our representative, took up the challenge in his address to the Geological Society in 1869, and asked the pertinent question "but is the earth nothing but a cooling mass 'like a hot water jar such as is used in carriages' or 'a globe of sandstone'?" And he was able to point out at least some agencies which might regenerate the earth's heat or delay its loss.

So it is only fitting that the great physicist, who imposed a narrow limit to geological time, should have prepared the way for those who have proved that the earth possesses in its radioactive substances a 'hidden reserve' capable of supplying a continuous recrudescence of the energy wasted by radiation, thus lengthening out the time required to complete its total loss. These later physicists have given us time without stint; and, though this time is the merest fraction of that envisaged by cosmogonists and astronomers, we are now so much richer than our original estimates that we are embarrassed by the wealth poured into our hands. So far from the last century's urge to 'hurry up our phenomena,' we are almost at a loss for phenomena enough to fill up the time.

The far-sighted genius of Lord Rutherford and Lord Rayleigh first saw the bearing of the rate of disintegration of radioactive substances in the minerals of rocks on the age of the parts of the earth-crust built of them. The extension and supplementing of this work by Joly, Holmes, and others, has now enabled us to look to the disintegration of uranium, thorium, and potassium, as the most promising of many methods that have been used in the endeavour to ascertain the age of those parts of the earth-crust that are accessible to observation. These methods also promise a means of dating the geological succession of Eras and Periods in terms of millions if not hundreds of thousands of years.

The decline and early death to which Lord Kelvin's dictum had condemned the earth, according so little with the vigour displayed in its geological story, is now transformed into a history of prolonged though not perennial youth. It was for

Joly, of whose work the extent, variety and fruitfulness are hardly yet fully appreciated, to take the next step and see in the release of radioactive energy a mechanism which could drive the pulse that geologists had so long felt, and that Suess had so brilliantly diagnosed. As Darwin found the missing word for Lyell, so Joly in his theory of Thermal Cycles has indicated the direction of search for a mechanism to actuate the rhythm of Suess.

In Joly's conception the running down of the earth's energy, though a continuous process, was, through the intervention of radioactivity, converted into a series of cycles, during each of which relative movements of sea and land must occur; downward movements of the continents, associated with positive encroachments of the sea; upward movements, with retreat of the sea, the formation of wide land masses, and the ridging of strata to form mountain ranges. Thus he forged a link that could unite the continental or epeirogenic movement with orogenic or mountain movement.

The visible parts of mountains and continents, as well as their lower and hidden portions, or 'roots', are made of comparatively light rocks. In order to stand up as they do their roots must be embedded in denser matter, in which they 'float' like ice-bergs in water. A far larger mass must exist below than is visible above, and the bigger the upstanding part the bigger the submerged root. Over the larger area of the ocean floor, on the other hand, the thickness of material of low density must be very slight, and the denser layer must come close to the surface.

The study of earthquakes, to which the Seismology Committee of the British Association has made outstanding contributions, has yielded, from the times taken in transmission of vibrations through the earth, the best information as to the nature and state of the interior. It has proved that the dense layer is solid at the present time. It is probably no coincidence that the earth is also but just recovering from what is possibly the greatest period of mountain-building, if not the greatest negative movement of ocean retreat, that it has ever experienced.

But solidity cannot be the permanent condition of the substratum. Heat is generated in it by its own radioactivity, but, according to the terms of the hypothesis, cannot escape, in consequence of the higher temperature generated in the continental rocks which cover it. It is therefore retained in the substratum and stored as latent heat of liquefaction, so that, within a period which has been calculated approximately in millions of years, complete melting of the sub-crust must ensue.

The resulting expansion of the liquefied stratum will have at least two effects of great importance to us. In the first place the unexpanded superficial layers will be too small to fit the swelling interior. They will, therefore, suffer tension, greater on the ocean floor than on land, and cracking and rifting will occur, with intrusion and extrusion of molten rock. In the second place the continental masses, now truly floating in a substratum which has become fluid and less dense than before, will sink deeper into it, suffering displacement along the rift cracks or other planes of dislocation. As a result the ocean waters, unchanged in volume, must encroach on the edges of the continents, and spread farther and farther over their surfaces.

Thus we have the mechanism which Suess vainly sought, causing positive movements of the oceans, their waters spreading over wide stretches of what was formerly continental land, and laying down as sediment upon it the marine stratified rocks which are our chief witness of the rhythmic advances of the sea.

This condition, however, cannot be permanent, for by convection of the fluid basic substratum, supplemented by the influence of tides within it, and the slow westward tidal drag of the continental masses towards and over what had been ocean floor, there will now be dissipation of its heat, mainly into the ocean waters, at a rate much faster than it has been or could be accumulated. Resolidification ensues, and again there are two main consequences. First, the stratum embedding their roots having now become more dense, the continental masses rise, and as they do so the ocean waters retreat from their margins and epicontinental seas, leaving bare as new land, made of the recently deposited sediments, the areas previously drowned. Secondly, the expanded crust, left insufficiently supported by the withdrawal of shrunken substratum, will suffer from severe tangential stress, and, on yielding, will wrinkle like the skin of a withering apple. The wrinkles will be mountain ranges, formed along lines of weakness

such as those at continental margins; and they will be piled up and elevated to suffer from the intense erosion due to water action upon their exposed and upraised rocks.

In this, again, we have a mechanism which supplies what was needed by Suess, and one, moreover, which secures the required relationship between continental and mountain movement, between the broader extensions of continental land and the growth of mountains with their volcanoes and earthquakes and the other concomitants of lateral thrust.

Thus a Thermal Cycle may run its full course from the solid substratum, through a period of liquefaction accompanied by crustal tension, back to solidification and an era of lateral stress: and the stage is set for a new cycle.

Professor Arthur Holmes, in checking Joly's calculations, has concluded that the length of the cycles in a basic rock substratum should occupy from 25 to 40 million years, a period much too short to fit the major periods of mountain movement, as determined by him from the radioactivity of minerals contained in the rocks. On this evidence the Alpine movement should date back from 20 to 60 millions of years ago, the Hercynian 200 to 250 millions, and the Caledonian from 350 to 375 million years.

In a preliminary attempt to modify Joly's hypothesis Holmes postulated the occurrence of similar, but longer cycles (Magmatic Cycles) in a denser, ultrabasic layer underlying the basic one, the rhythm of which would be nearer to 150 million years. The shorter cycles due to the basic layer are held in part responsible for periods of minor disturbance, and also to account for the individual variations in effect, duration, and intensity of the larger ones. Each of the later movements has also evidently been limited and conditioned by the results of foregoing ones, and especially by areas of fracture and weakness on the one hand, and by large stable masses composed of rocks intensely consolidated, or already closely packed, on the other.

More recently Holmes has developed the possibility that the loss of heat is mainly due to convection in the liquid substrata, and that convection is the leading cause of the drifting and other movements of the crust, and the disturbances that have occurred in it. He says:—

'Although the hypothesis involving sub-crustal convection currents cannot be regarded as established, it is encouraging to find that it is consistent with a wide range of geological and geophysical data. Moreover, it is by no means independent of the best features of the other hypotheses. It requires the local operation of thermal cycles within the crust, and it necessarily involves contraction in regions where crustal cooling takes place. It is sufficiently complex to match the astonishing complexities of geological history, and sufficiently startling to stimulate research in many directions.'

The phenomena are difficult to disentangle as the number of operating causes has been so great and many of them are not fully understood. But, underlying them all there is unquestionably the pulse within pulse which Suess saw and of which Joly pointed the way to explanation.

The view at which we have arrived is neither strictly uniformitarian nor strictly catastrophic, but takes the best from each hypothesis. As Lyell showed, most of the phenomena of geology can be matched somewhere and sometime on the earth of to-day; but it would appear that they have varied in place, intensity, phase, and time. And, as Lyell was driven to accept *evolution* to explain the history of life on the earth, so must we employ the same word to express the life-processes of the earth itself, as was suggested by Huxley in 1869 and strongly advocated by Sollas in 1883.

The contrast in outline and structure between the Atlantic and Pacific Oceans had long been noted when Suess formulated and used the differences as the basis of his classification.

The Pacific is bounded everywhere by steep slopes, rising abruptly from profound ocean depths to lofty lands crowned with mountain ranges, parallel to its shores and surrounding its whole area. On the American side the Coast Range is continued by the Andes. On the Asiatic side chains of mountainous peninsulas and islands, separated from the continent by shallow inland seas, extend in festoons from Kamchatka and Japan to the East Indies, eastern Australia and New Zealand. This mountain ring, as Charles Lapworth said, 'is ablaze with volcanoes and creeping with earthquakes,' testifying that it has been recently formed and is still unfinished.

The Atlantic Ocean, on the other hand, is not bordered with continuous ranges, but breaks across them all: the Scottish and Welsh ranges, the Armorican range, the continuation of the Pyrenees and Atlas; and, on the American side, the uplands of

Labrador, Newfoundland and the eastern States, and the hill ranges of Guiana and Brazil. The Atlantic is in disconformity with the grain of the land, while the Pacific conforms with it. The Pacific has the rock-folds of its ranges breaking like ocean waves towards it as though the land were being driven by pressure to advance upon it, while the Atlantic recalls the effects of fracture under tension.

The middle and southern edges of the Atlantic, however, agree to some extent with the Pacific type. The Caribbean Sea, with the Antilles and the rest of its border girdle, recalls the similar structure of the Mediterranean, as it stretches eastwards, with breaks, to the East Indian Archipelago; while the Andes are continued to Antarctica in a sweeping curve of islands. The rest of the Indian Ocean is of Atlantic type, as seen in the shores of eastern Africa and western Australia.

Another feature of the Atlantic is the parallelism of much of its eastern and western coasts, the meaning of which has often attracted the speculations of geologists and geographers. With a little stretch of the imagination, and some ingenuity and elasticity of adjustment, plans or maps of the opposite sides may be fitted fairly closely, particularly if we plot and assemble the real edges of the continents, the steep slopes which divide the 'shelves' on which they stand from the ocean depths. This has suggested the possibility that the two sides may once have been united, and have since broken and drifted apart till they are now separated by the ocean.

This view, outlined by others, has been emphasised by Wegener and dealt with by him in full detail in his work on *The Origin of Continents and Oceans*, and it now plays a leading part in what is known as the Wegener theory of continental drift. The hypothesis is supported by the close resemblances in the rocks and fossils of many ages in western Europe and Britain to those of eastern North America; by community of the structures by which these rocks are affected; and by the strong likeness exhibited by the living animals and plants on the two sides, so that they can only be referred to a single biological and distributional unit, the Palæarctic Region.

The hypothesis, however, did not stop at this; and in the South Atlantic and certain other areas Wegener and his followers have also given good reasons for believing that continental masses, once continuous, have drifted apart.

Broad areas in southern Africa are built of rocks known as the Karroo Formation, of which the lower part, of late Carboniferous age, is characterised especially by species of the strange fern-like fossil plants Glossopteris and Gangamopteris. Associated with them are peculiar groups of fossil shells and fossil amphibia and reptiles. Similar rocks, with similar associations and contents, in Peninsular India have been named the Gondwana Formation. Comparable Formations also occupy large regions in Australia, Tasmania and New Zealand, in Madagascar, in the Falkland Islands and Brazil, and in Antarctica.

The correspondence between these areas is so close that Suess supposed they must at that date have been connected together by lands, now sunk beneath the sea, and he named the continent thus formed Gondwanaland after the Indian occurrences. The break-up of this land can be followed from a study of the rocks, and it was a slow process, its steps occupying much of Mesozoic time. Dr. A. L. du Toit's comparison of South African rocks with those of Brazil and elsewhere in South America favours even a closer union than this between the units now scattered.

One of the most remarkable features shown by these rocks in all the areas mentioned, but to varying extents, is the presence of conglomerates made of far-travelled boulders, scratched like those borne by the modern ice-sheets of Greenland and the Antarctic, associated with other deposits of a glacial nature, and often resting upon typical glaciated surfaces. There is no possible escape from the conclusion that these areas, now situated in or near the tropics, suffered an intense glaciation. This was not a case of mere alpine glaciers, for the land was of low relief and not far removed from sea-level, but of extensive ice-sheets on a far larger scale than the glaciation of the northern parts of the new and old worlds in the Pleistocene Ice Age. I have never seen any geological evidence more impressive or convincing than that displayed at Nooitgedacht, near Kimberley; while the illustrations and other evidence published by David and Howchin from Australia are equally striking.

Du Toit's work on these glacial deposits brings out two remarkable facts; first, that the movement of the ice was southerly, poleward and away from the equator, the

opposite to what would be expected, and to the direction of the Pleistocene ice-movement; secondly, that the ice in Natal invaded the land from what is now sea to the north-east.

When it is realised that at this period there is no evidence of glacial action in northern Europe or America, but a climate in which grew the vegetation that formed the coal seams of our Coal Measures, it is clear that we are not dealing with any general refrigeration of the globe, even if that would produce such widespread glaciation: we are face to face with a special glaciation of Gondwanaland.

On both sides of the Atlantic these glacial episodes in Carboniferous times were followed by dry and desert climates in Triassic time, and these by violent volcanic outbursts. Nor are the rocks alike only in mode of formation, the structures by which they are traversed correspond; while even in details there is remarkable agreement, as in the peculiar manganese deposits, and the occurrence of diamonds in 'pipes' of igneous rock, both east and west of the Ocean.

Rather than face the difficulties presented by the subsidence of lands connecting the severed portions of Gondwanaland, as pictured by Suess, Wegener has preferred, and in this he is supported by Du Toit and many other geologists, to bring into contact these severed parts, which could be fitted together as nearly as might be expected, considering the dates of severance. Du Toit's map of the period places South America to the west and south of South Africa, Madagascar and India to the east, Antarctica to the south, and Australia farther to the south-east. Such a grouping would form a continent much less wide in extent than that envisaged by Suess, and would offer some explanation of the more remarkable features of the glaciation in the several areas, as well as the problems of the rocks, fossils, and structures involved.

In its application to the geology of Gondwanaland the modified hypothesis of Wegener cuts a Gordian knot; but it still leaves a great climatal difficulty, unless we take his further step and conceive that at this date the terrestrial south pole was situated within Gondwanaland. No shift in the axis on which the earth rotates would, of course, be possible, nor is it postulated: only a drifting at that date of continental land across the pole.

If a hypothesis of drift be admitted for Gondwanaland, it would be illogical to deny its application to other regions, including the north Atlantic. I have already mentioned some facts in its favour. Others are the resemblances of all sedimentary rocks on the two sides from the Cambrian to the Ordovician, and from the Devonian to the Trias; the links between the structures of the land, as, for instance, between Ireland and Newfoundland; and the instance given by Professor Bailey in his address to Section C in 1928. As Bailey then pointed out, the great Caledonian range which crosses Scotland, northern England and Wales from north-east to south-west on its course from Scandinavia is affected and displaced by the east to west Armorican (Hercynian) chain extending across from Brittany to South Wales. 'The crossing of the chains, begun in the British Isles, is completed in New England'; and from here the Armorican structure continues its westerly course. This is where it should cross if the continent of North America were brought back across the Atlantic and placed in the position which, according to Wegener, it would fit into in the European coast! Can the Pilgrim Fathers have ever dreamed of such a link between the Old England and the New?

The hypothesis of continental drift gave rich promise of solving so many difficult problems that it was hailed by many classes of investigators almost as a panacea. Geographers have seen in it an explanation of the forms of continents and the position of peninsulas, islands and mountains; meteorologists have found it the solution of some of the problems of past climates and their anomalies of distribution over the world; biologists hope to get help with the intense complexities in the distribution of forms of life and many strange facts in migration, and palæontologists with similar difficulties among the ancient faunas and floras as revealed by their fossil remains; geodesists have welcomed escape from the rising and sinking of the crust, so difficult to reconcile with the demands of isostatic equilibrium; and it has been already stated that drift forms a vital factor in Joly's thermal cycles.

But there has been no lack of criticism in all these directions. It has been assailed on the one hand for the detail attempted in its geographical restorations, and on the other hand for its vagueness. Prof. Schuchert quotes Termier as saying that it is 'a beautiful dream, the dream of a great poet. One tries to embrace it, and finds that he has in

his arms but a little vapour or smoke: it is at the same time alluring and intangible.' It has been objected that 'no plausible explanation of the mechanics involved has been offered'; that the continental connexions postulated present by no means so close a match, when fitted together, as has been claimed, in the structure or the nature of either igneous or sedimentary rocks; that there is good evidence of extensive vertical movements in recent earthquakes, in the accumulation of tremendous thicknesses of sediment indicative of shallow-water from base to summit, and in the growth of coral reefs; that Central America and the Mediterranean are a difficult obstacle; and that the known distribution of the Karroo fossil reptiles is not by any means what the hypothesis demands.

If the idea of drift be accepted it cannot be regarded as a royal road out of all our difficulties, nor can it be the only form of earth-movement to be reckoned with. The late J. W. Gregory, whose life was sacrificed to geological discovery, has studied exhaustively the geological history of the Atlantic and Pacific Oceans, both as revealed by the sedimentary rocks and fossils on their borders, and by the distribution of life to-day. He finds that, according to our present knowledge, in the two oceans, facilities for migration have fluctuated from time to time, periods of great community of organisms alternating with periods of diversity. Again, at some times connexion seems to have been established north of the equator, at others to the south; and we cannot ignore the possibility of migration across polar lands or seas when terrestrial climates have differed from the present. The facts of life distribution are far too complex to be explained by any single period of connection followed by a definite breaking apart, even if that took place by stages. Mrs. Reid, too, has pointed out that resemblances between the Tertiary floras of America and Europe actually increased at the time when the Atlantic should have been widening. Unless continental drift has been a more complicated process than anyone has yet conceived, it seems impossible to escape from some form of the 'land bridges' of the older naturalists:

'Air-roads over islands lost—
Ages since 'neath Ocean lost—'

We have no right to expect greater simplicity in the life of a planet than in that of an organism.

As the question of drift must in the last appeal be one of fact, it is not unnaturally expected that the real answer will come from measurements of longitude and latitude with greater exactness and over periods longer than has yet been possible. None of the measurements hitherto made has indicated variations greater than the limits of errors of observation. Two things, however, may militate against a definite answer from this source. Many parts of the crust, such as the shield-like masses of Archæan rock, may have completed their movement, or be now moving so slowly that the movement could not be measured. Careful selection of locality is essential, and at present we have little guidance. Also, as the displacement of crust must be dependent on the condition of its substratum, it will be a periodic phenomenon and the rate of movement may vary much in time. According to the theory of thermal cycles the subcrust is at present solid, and may not permit of drift. Drift, according to Joly and Holmes, is a cyclical phenomenon; if present-day observations were to give a negative result they would not necessarily disprove it.

The occurrence of recumbent rockfolds, and nearly horizontal slides or 'nappes' in mountain regions, gives positive proof that parts of the upper earth-crust have moved over the lower. In the North-west Highlands of Scotland a sliding of at least ten miles was proved by Peach and Horne, and in Scandinavia it amounts to sixty miles. For mountain packing as a whole the figures already given are far larger, while in Asia Argand has stated that packing of over 2,000 miles has occurred. Thus, when all is said and done, movements on a colossal scale are established facts, and the question of the future is how far we shall accept the scheme of drift due to Wegener, or one or other of the modifications of it. It is for us to watch and test all the data under our own observation, feeling sure that we shall have to adapt to our own case Galileo's words 'e pur si muove'.

Ever since it was realised that the inclination and folding of rocks must be attributed to lateral or tangential stress and not solely to uplift, shrinkage of the interior of the earth from its crust has been accepted as the prime mover, and whichever of the current theories we adopt we cannot deny the efficacy of so powerful a cause.

The general course of events in the formation of a mountain range is fairly well known;

the slow sinking of a downfold in the crust during long ages; the filling of this with sediment *pari passu* with the sinking, and associated softening of the sub-crust due to accumulated heat; the oncoming of lateral pressure causing wave-like folds in the sediments and the base on which they rest; the crushing of folds together till, like water waves, they bend over and break by overdriving from above or, it may be, underdriving from below; fracture of the compressed folds and the travelling forward for great distances of slivers or 'nappes' or rock, generally of small relative thickness but of great length and breadth, and sliding upon floors of crushed rock; the outpouring and intrusion of igneous rocks, lubricating contacts and complicating the loading of the sediments; metamorphism of many of the rocks by crystallisation at elevated temperatures and under stress, with the development of a new and elaborate system of planes of re-orientation and movement; and elevation of the whole, either independently or by thickening with compression and piling up to bring about a fresh equilibrium.

Such a course of events would be brought about by lateral pressure developed during the consolidation phase of each of the thermal or magmatic cycles. At each period of their building, mountains have arisen along lines of weakness in the crust, especially coast lines and the steep slopes marking the limits between continents and ocean basins. This is consistent with Joly's theory that the thrust of ocean beds against land margins is the cause.

But the advocates of continental drift point to the siting of ranges across the paths along which the drifting movement is supposed to have occurred, and they consider that the moving masses are responsible; and indeed that the ridging and packing of the crust has in the end checked and stopped the movement. They note that the great western ranges of America occur in the path of any western drift of that continent, the Himalayas in the course of the postulated movement of India, the East Indies in front of Australia; and that the Alpine ranges of Europe may be linked with the crushing of Africa towards the north.

The 'nappes' of rock, cut off from their origin and sliding for dozens of miles, are a constant source of wonder to all who have considered the mechanics of mountain formation. They are so thin as compared with their great length and breadth, that it seems impossible to imagine them moved by any force other than one which would make itself felt throughout their every particle. Such a force is gravitation, and it is of interest that some Alpine geologists and Dr. Harold Jeffreys have used it in explanation of them. Professor Daly has also adopted gravitation on an even greater scale in his theory of continental sliding: and one cannot fail to notice the increasing use of the term 'crust-creep' by those working on earth-movement.

Is there no other force, comparable in its method of action to gravitation, but capable of producing movement of the earth-crust in a direction other than downhill? Is it not possible, for instance, that the tidal influence of the moon and sun, which is producing so much distortion of the solid earth that the ocean tides are less than they would be otherwise, and, dragging always in one direction is slowing down the earth's rotation, may exert permanent distorting influence on the solid earth itself? May it not be that such a stress, if not sufficiently powerful to produce the greater displacements of continental drift and mountain-building, may yet take advantage of structures of weakness produced by other causes, and itself contribute to the formation of nappes and to other movements of a nature at present unexplained?

Our knowledge of geology has been gained by the survey of the rocks, the study of their structures, and the delineation of both upon maps and sections. This work is being accomplished by geologists all over the world, and this country and its dependencies have contributed their full share. It is therefore opportune to note that there has just been celebrated the Centenary of the Geological Survey of Britain and, with it, the opening of the new Geological Museum at South Kensington.

A century ago H. T. de la Beche, one of the devoted band of pioneer workers then studying the geology of the country, offered to 'affix geological colours to the new maps of Devon and Cornwall' then in course of issue by the Ordnance Survey. His offer was accepted, and, at his own expense and on his own feet, he carried out a geological survey of some 4,000 square miles. In 1835 he was appointed to continue this task, with a small salary and a few assistants. Thus was started the first official geological survey, an example widely followed by other nations

and dominions. De la Beche's conception included also a Museum of economic and practical geology, a Library, a Record of Mines, for which he secured support from a strong Committee of the British Association in 1838, and a School of Mines for the scientific and technical education of those to be employed in the survey or exploitation of mineral resources. In these objects, and especially the last, he was warmly supported by the Prince Consort. He lived to see his visions all come true, as he collected round himself that wonderful band of surveyors, investigators, writers and teachers, which included such men as Playfair, Logan, Ramsay, Aveline, Jukes, Forbes, Percy, Hooker and Huxley.

Some of the schemes he planned have budded off and grown into large and important entities, rendering conspicuous service to scientific record, education and research. But the main duties of the Geological Survey remained with it, and have been carried on for a century. These are to map the geology of the country on the largest practicable scale, to describe and interpret the structure of the land, to preserve the evidence on which conclusions have been founded, and to illustrate for students and other workers the geology of the country and its applications to economics and industry. The broad detail of the structure of the whole country is now known, but much new work must be done to keep abreast of or to lead geological thought. For instance, the study of the cloak of 'superficial deposits,' which often cover and conceal the structure of the more solid rocks below, is essential for the proper understanding of soils and agriculture; and a knowledge of the deep-seated geology of the country, which is often widely different from that nearer the surface and thus very difficult to interpret, is vital to the community for the successful location and working of coal and iron, and for tracing supplies of water and oil and other resources at depth.

Evolution of life on the earth has been by no means uniform; there have been periods of waxing and waning which may be attributed to geographical, climatological and biological influences. The development of large land areas, ranged longitudinally or latitudinally, the invasion of epicontinental seas, the isolation of mediterraneans or inland seas, the splitting of continental areas into archipelagoes or the reunion of islands into continuous land, the making of barriers by the rearing of mountain chains or the formation of straits or arms of the sea, the oncoming of desert or glacial climates; all such factors and many others have been of importance in quickening or checking competition, and in accelerating or retarding the evolution of life.

Probably, however, even greater effects have followed the interaction of groups of biological changes on one another. As an instance I might recall Starkie Gardner's estimate of the results following upon the first appearance of grasses in the world. This seems to have been not earlier than Eocene, and probably late Eocene times. By the Oligocene they had made good their hold, peculiarities in their growth and structure enabling them to compete with the other vegetation that then existed; and gradually they spread over huge areas of the earth's surface, formerly occupied by marsh, scrub and forest. They have, as Ruskin says, 'a very little strength....and a few delicate long lines meeting at a point. . . made, as it seems, only to be trodden on to-day, and to-morrow to be cast into the oven'; but, through their easy growth, their disregard of trampling and grazing, and by reason of the nourishment concentrated in their seeds, they provided an ideal and plentiful source of food. On their establishment we find that groups of animals, which had previously browsed on shrubs and trees, adopted them, with consequent alterations and adaptations in their teeth and other bodily structures. To follow their food from over-grazed or sun-scorched regions they required to be able to migrate easily and quickly, and it was essential for them to discard sedentary defence and to flee from threatened danger. Such defence as was possible with heels, teeth, or horns, they retained; but the dominant modifications in their organisation were in the direction of speed as their most vital need.

Side by side with this development, and in answer to increasing numbers, came bigger, stronger and speedier carnivores, to feed on prey now so much more abundant, but more difficult to catch. The answer of the grass-feeders, with their specialised hoofs, teeth and bones, better suited to flight than fight, was to seek safety in numbers, and thus develop the herd instinct, with its necessity for leadership and discipline; but this, in turn, provoked a like rejoinder from some types of their enemies.

When it is remembered how much of the

meat and drink and life of mankind is bound up with the grasses, including wheat, maize, millet and other grains, sugarcane, rice and bamboo, we must realise how close is his link with the development just outlined. Practically his whole food supply is provided by them, either directly by the agriculturist who grows little else but grasses, or indirectly by the herdsman whose domestic animals are fed chiefly on the same food. Nor must we forget that almost every one of our domesticated animals has been derived from the gregarious types just mentioned, which have accepted the leadership of man in place of that of their own species.

It is perhaps not too much to say that the magnificent outburst of energy put out by the earth in the erection of the Alps, Andes, and Himalayas in Tertiary times was trivial in its influence for man's advent and his successful occupation of the earth in comparison with the gentle but insidious growth of 'mere unconquerable grass' and its green carpet of 'wise turf' which in some form clothes by far the greater part of the land of the globe.

The kind of developmental reaction of which this is but a single example must clearly have had influence on bodily features, other than bones and horns, teeth and claws, speed and strength; and one of the most striking has been on intellectual development and the size and shape of brain.

We do not, and perhaps can never, know the quality of the material of which the brains of fossil creatures was made, for we have no instrument to pierce the veil of time as the spectroscope has penetrated the abysm of space. But we are even now learning something about their shapes and convolutions, and more about their mass in its relation to the size of the bodies controlled; from the time of the earliest Ordovician fishes, through the history of the amphibia, reptiles, birds and mammals up to man himself.

The brain of those gigantic if somewhat grotesque reptiles the dinosaurs, the tyrants of Mesozoic time, is relatively tiny. In Diplodocus, 80 feet in length and 20 tons in weight, the brain was about the size of a large hen's egg. It is true that there was a big supplementary sacral ganglion which may have taken chief charge of locomotion and helped to secure co-ordination throughout the hinder part of its huge length and bulk; but of true brain there was not more than a quarter of an ounce to control each ton of body and limb; and we begin to understand why they lost the lordship of creation.

The proportion of brain to body improved in those reptiles which took to flying, possibly in relation to their acquisition of warm blood, and in the birds evolved from reptiles; but it is only in mammals that a marked advance is seen. Here the brain of Uintatherium, a great rhinoceros-like animal of Eocene date, weighing 2 tons, was about the size of that of a dog. This proportion of half a pound of brain to each ton of body shows how far the mammals had gone, and still had to go.

A 12-stone man of the present day has about 3½ pounds of brain—an amount not far short of half a hundredweight per ton.

Even though we can know nothing of its material, this steadfast growth in the guiding principle, through the millions of centuries that have gone to its development, is surely one of the most remarkable conclusions that we owe to geology. Of all the wonders of the universe of which we have present knowledge, from the electron to the atom, from the virus and bacillus to the oak and the elephant, from the tiniest meteor to the most magnificent nebula, surely there is nothing to surpass the brain of man. An instrument capable of controlling every thought and action of the human body, the most intricate and efficient piece of mechanism ever devised; of piercing the secrets and defining the laws of nature; of recording and recalling every adventure of the individual from his cradle to his grave; of inspiring or of ruling great masses of mankind; of producing all the gems of speech and song, of poetry and art, that adorn the world, all the thoughts of philosophy and all the triumphs of imagination and insight: it is indeed the greatest marvel of all.

And when we contemplate the time and energy, the sacrifice and devotion, that this evolution has cost, we must feel that we are still far from the end of this mighty purpose: that we can confidently look forward to the further advance which alone could justify the design and skill lavished on this great task throughout the golden ages that have gone.

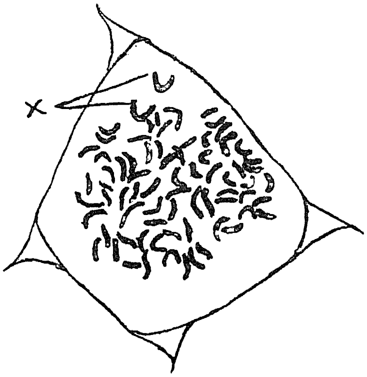

Fig 1.

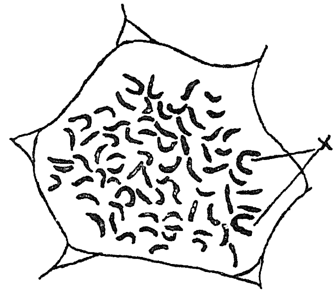

Fig 2.

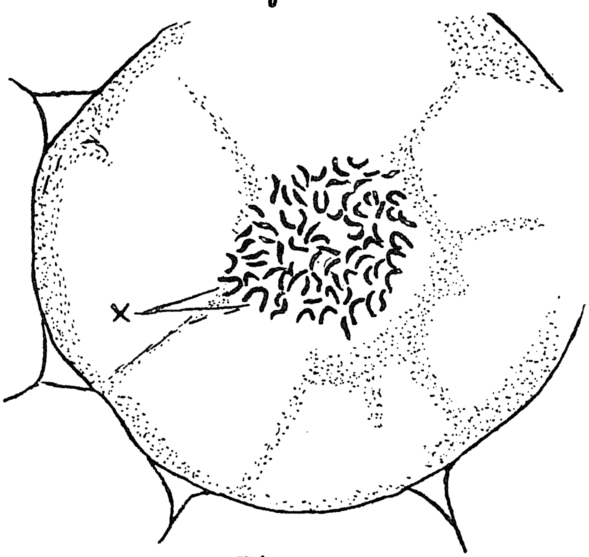

Fig 3.

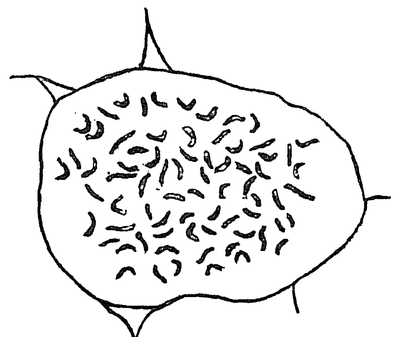

Fig 4.

Fig. 1. *H. sabdariffa* var Ruber. Fig. 2. *H. sabdariffa* Bhagalpuriensis.
Fig. 3. *H. sabdariffa* Altissima. Fig. 4. *H. cannabinus*.
U-shaped chromosomes in figures 1 to 3 marked ×.

with another maximum division phase at 11 P.M. thereby showing a periodicity in mitosis. A number of somatic metaphase plates were counted in the two species and in each case the number was found to be 72 (Figs. 1 to 4). A preliminary examination of chromosome complements in the two species revealed certain morphological differences. The chromosomes were thicker and longer in *H. sabdariffa* than those in *H. cannabinus* and in the former species there was a greater number of U- and V-shaped chromosomes (Figs. 1 to 3) while in the latter there was greater number of rod-like chromosomes.

M. B. V. NARASINGA RAO.

Rice Research Station,
Berhampore,
September 4, 1935.

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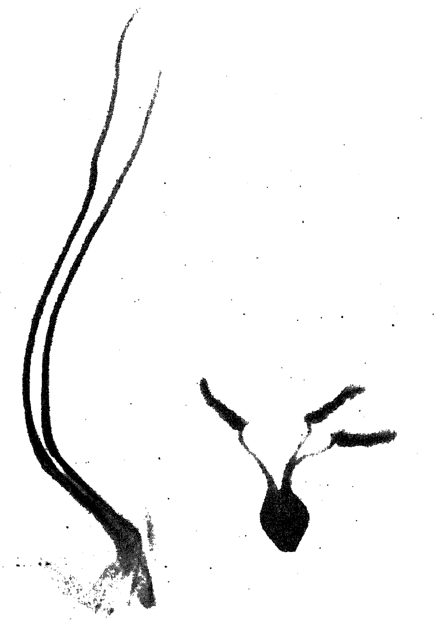
* This study was undertaken by the author while he was a post-graduate student at Pusa during 1930-32.

[1] Davie, *J. Genetics*, 1934, 28, 33-67.

Further Data on the Homology of Stigmas and Awns.

In a previous paper (G. N. Rangaswami Ayyangar and V. P. Rao, 1935)[1] the homology of stigmas and awns was dilated upon. In this note further data obtained is presented.

The first experience is from a very rare phenomenon in a family of sorghum in which the awns instead of being single, forked into two (Fig. 1). A careful examination of the stigmas was made with a view to look out for any possible repercussions of this forking of the awn. In one instance, three stigmas were noted (Fig. 1), with no aberrations in the ovary. According to Walker (1906)[2] in the tricarpellate pistils of *Andropogoneæ* two of the carpels normally form the bulk of the ovary and bear the style branches while the third carpel bears



Forked Awn. Forked Stigma.

Fig. 1.

the ovule. The photograph of the forked style is unmistakable in its import. Few and feeble as the response of the stigma has been, it is nevertheless significant.

The second evidence, derived from a cross between *Sufra*, a variety of sorghum from the Sudan and *Chinna Manjal Cholam*, a Coimbatore variety, is telling. In *Sufra*, which is awnless, the length of the stigma and style is unequal. *Chinna Manjal Cholam* has awns in which the column and the subule are of equal length. So also the stigmatic and stylar lengths. The F_1 was awnless and had styles and stigmas of equal length. In the second generation there was

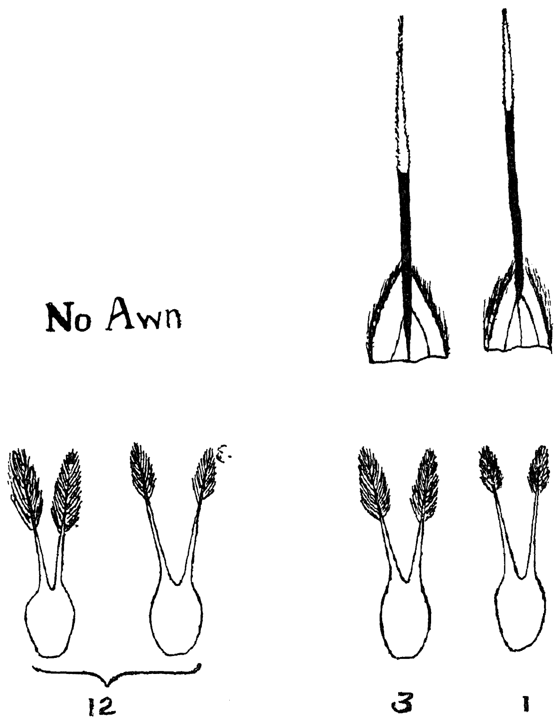


Fig. 2.

a segregation both for awn and for stigmatic distribution. Nil awn is dominant to long awn (Rangaswami Ayyangar, 1934).[3] In this cross equal distribution between stigmatic and stylar lengths proved a simple dominant to short stigma. The interest of the cross arises in the relationship between stigma and awns. The homology between stigmas and awns could not be pursued in the dominant awnless group which contained the two sets of stigmas. In the awned group also, there were both kinds of stigmas with this additional interest that being awned, equality and inequality of stigmatic surface kept parallel to the subular area of the awn (Fig. 2). A 12 : 3 : 1 ratio (actual figures 133, 33, 9) was obtained for the three groups, awnless, awned with equal lengths of subule and column and stigma

and style, and awned with unequal lengths of subule and column and stigma and style.

G. N. RANGASWAMI AYYANGAR.
V. PANDURANGA RAO.

Agricultural Research Institute,
Coimbatore,
September 6, 1935.

[1] *Curr. Sci.*, 1935, **3**, 540.

[2] *Univ. Nebraska Studies*, 1906, **6**, 203.

[3] *Madras Agric. J.*, 1934, **22**, 16.

Diurnal Insects Attracted to Light.

OUR knowledge of the activities at night of diurnal insects is still meagre, but among the butterflies, the Hesperiidæ, Pieridæ and Satyridæ are already known to occur at night. It is, therefore, interesting to record here for the first time the attraction to powerful artificial light of the Lycænid, *Zizeeria otis otis* F., which Dr. Rao recently collected in Aberdeen, Port Blair, South Andamans.

In this case all the seven specimens (4 ♂s and 3 ♀s) were attracted, along with other insects, to the light of an 'Aida' kerosene stormproof lantern in the bungalow between 7 and 8 P.M. on a single night last July. The bungalow is about a furlong from the foreshore of the sea and 60 feet above sea-level. The brilliancy of the light of the lantern is 350 candle power. The vegetation surrounding the bungalow consists of grass and low herbage interspersed with a few trees. The weather was not unusual for the particular time of the year, and there was no strong breeze blowing at the time.

From the literature available it is evident that the Lycænidæ are exclusively diurnal and fond of sunshine.[1] Seitz[2] comments upon their peculiar habit in tropical countries of disappearing almost at once when the sky becomes overcast with clouds. He also remarks that he has never seen any coming to the light of a lantern at night. This may perhaps have been due to the low intensity of the light. The fondness of *Z. otis otis* F., for bright light, therefore, proves it to be positively heliophilous. *Zizeeria otis otis* F., is a small low-flying butterfly which frequents grass, being found commonly wherever it occurs. The species is recorded from North India, Burma, Andamans, and Car and Central Nicobars.

I am grateful to Dr. H. S. Rao, Assistant Superintendent, Zoological Survey of India, Calcutta, for his notes on the nature of the environment, the weather and time of occurrence.

S. RIBEIRO.

Zoological Survey of India,
Indian Museum, Calcutta.
September 2, 1935.

[1] Dr. Rao informs me that he has observed on occasions these Lycænids hovering over the hedge-plants around the bungalow at mid-day.

[2] Seitz, A., *The Macro-Lepidoptera of the World (Indo-Australian Rhopalocera)*, Lycænidæ, 1915, **9**, 799.

On Two New Halcampactid Actiniaria from Madras Brackish Waters.

THE Actiniaria inhabiting the brackish waters of Madras include two new acontiated Athenaria[1] belonging to the family Halcampactidæ,[2] showing relationships to *Pelocœtes exul* Annand. and *Phytocœtes gangeticus* Annand., described by the late Dr. Annandale from the Chilka Lake and the Gangetic delta.[3,4] In a note, Dr. H. S. Rao[5] records the occurrence of some brackish water Actinians at Madras; but as no detailed study was made, he did not commit himself to any definite view about systematic position.

The two anemones differ from all the other known Halcampactids and they will be described elsewhere as two new forms. Both the Actinians have long vermiform and fairly differentiated columns, and physa-like bases without basilar muscles. They are burrowing forms found living in the shallow mud flats on the fringes of the Adyar backwater. The distinction of the mesenteries into microcnemes and macrocnemes is perfect in both cases.[6]

The first is a long pink anemone characterised by a curious atypical arrangement of the tentacles and acontia. Here the tentacular arrangement is a deviation from that observed in typical Actiniaria, caused by an interchange of the two final cycles accompanied by an undue development of the tentacles of the fourth cycle, which by their abnormal position assume a false exocœlic appearance. Contrary to what is observed in other Actiniaria, each macrocneme of this anemone bears a very large number of acontia and the latter show very peculiar variations in regard to their

attachment to the macrocnemes. An interesting correlation between the degree of development of the acontia and the probable order of succession of the macrocnemes has been observed as a result of the examination of a large number of specimens.

The second form is a beautiful, orange-striped anemone with black marks at the bases of the tentacles. It is easily distinguished by the nature of the oral disc, the very prominent throat ridges which surround the mouth taking an active part in feeding. The plan of arrangement of the tentacles and acontia of this anemone does not present differences from that observed for typical Actinians. The single acontium occurring on each macrocneme is a long thick structure, which is often shot out through the cinclides.

The two anemones have more or less similar anatomical features, the differences being mainly concerned with the finer details. The nature of the base and column, the plan of mesenterial arrangement and the distribution of the nematocysts are essentially the same, and clearly show their close relationships and position in the same family. In both cases, the nematocysts of the acontia include both penicilli and spirulæ.[7]

Like other brackish water anemones known from the east coast of India,[3,4] these are permanent inhabitants of the brackish water and show several adaptations in correlation to their peculiar environs. The occurrence of a large number of parasitic (or commensal?) Copepods in the cœlenteron of the specimens is noteworthy.

I wish to thank Professors R. Gopala Aiyar and T. A. Stephenson, for much valuable help and criticism.

N. KESAVA PANIKKAR.

University Zoological Laboratory,
Madras,
July 25, 1935.

[1] Carlgren, O., *Actiniaria, The Danish Ingolf Expedition*, 1921, **5**, pt. 9, 1-241.

[2] Carlgren, O., *Ark. Zool.*, Stockholm, 1925, **Bd. 17 a**, 1-21.

[3] Annandale, N., *Rec. Ind. Mus.*, 1907, **1**, 47-74.

[4] Annandale, N., *Mem. Ind. Mus.*, 1915, **5**, 65-114.

[5] Rao, H. S., *Jour. Proc. As. Soc. Bengal*, 1925, **20**, No. 6, 339-347.

[6] Stephenson, T. A., *Quart. Jour. Micr. Sci.*, 1920, **64**, 425-574.

[7] *Jour. Mar. Biol. Assn., U. K.*, 1929, **16**, 173-200.

Sexual Dimorphism in the Indian House-Gecko, *Hemidactylus flaviviridis*, Rüppel.

WITH reference to sexual dimorphism in *Hemidactylus flaviviridis*, Rüppel, Baini Parshad[1] says: "The male is much smaller than the female and is much more active and agile, in build also it is much slighter and can be easily distinguished even from a distance." Lydekker,[2] on the other hand, says that "among geckos the males are generally larger".

An examination of more than three hundred preserved specimens and actual observations on live individuals do not confirm any one of these statements. The size appears to depend not on sex, but almost entirely on age and on the amount of food obtained by the individual. Quite a number of males in my collection measure 6–6·3 inches from snout to end of the original tail, the distance from snout to vent being in many cases 3 inches or more. This compares well with the maximum size recorded by Boulenger[3] for this species, "from snout to vent 3 inches; tail 3·2 inches;" and with that mentioned by Malcolm A. Smith,[4] "from snout to vent 90; tail 90 mm." I have also got a great many mature female specimens of this species which are far short of the maximum size.

As for activity, I have not been able to make out any difference between the two sexes. The gravid females probably are just a little less agile than the males, but we cannot be sure of this distinction.

It appears that the only reliable method of sex identification externally is to look for the femoral pores (present only in the male[5]) and for the postanal bones and sacs. The latter structures, first mentioned by Noble[6] and later by Malcolm A. Smith,[7] are peculiar to Geckonidæ. "The sac is present in both sexes, but the bone only in the male."[8] In the female *Hemidactylus*, the postanal sacs are much smaller and open by minute slit-like apertures generally within the posterior lip of the vent. In the male they are quite prominent and have their outer rims more or less protruded owing to the presence of a curved bone inside. As Smith[9] points out, the bone "can be recognised, after a little experience, without dissection by inserting the point of a needle into the opening of the sac and lifting the bone upwards."

Besides the foregoing differences, I might also point out (I hope for the first time in

this genus) a peculiarity of the male assumed during the breeding season, and that is the presence of two swellings on the ventral aspect of the base of the tail, separated by a slight longitudinal depression. The female has this area either flat or slightly concave. This distinction becomes prominent in March or April and shows signs of disappearing towards the close of the breeding season.

As far as I can ascertain, the only record about such swellings is by Annandale.[10] He, however, mentions it in *Gymnodactylus* and appears to have noted only one swelling, probably owing to the two males that he examined having suffered from over-long preservation. I am in a position to confirm his statement that the difference (at least in *Hemidactylus*) becomes prominent during the breeding season.

BENI CHARAN MAHENDRA.

St. John's College,
Agra,
July 30, 1935.

[1] Baini Parshad, "Some Observations on a Common House-Lizard (*Hemidactylus flaviviridis*, Rüppel) of India," *Journ. Bomb. Nat. Hist. Soc.*, 1916, **24**, 834.

[2] Lydekker, R., Cunningham, J. T., Boulenger, G. A., Thomson, J. A., "Reptiles, Amphibia, Fishes, and Lower Chordata," Methuen & Co., 1912, p. 63.

[3] Boulenger, G. A., "Fauna of British India (Reptilia and Batrachia)," 1890, p. 92, (*vide H. coctaei*).

[4] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," 1935, **2**, 98.

[5] *Ibid.*, 98.

[6] Noble, G. K., "The Bony Structure and Phyletic Relations of *Sphærodactylus* and Allied Lacertilian Genera, with a Description of a New Genus," *Amer. Mus.*, Nov. 4, 1921, pp. 1-16.

[7] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," 1935, **2**, 25-26; "Remarks on Some Old World Geckoes," *Rec. Ind. Mus.*, 1933, **35**, 9-10.

[8] *Op. cit.*, p. 9.

[9] Smith, M. A., "Fauna of British India (Reptilia and Amphibia)," 1935, **2**, 25-26.

[10] Annandale, N., "New and Interesting Lizards in the Colombo Museum," *Spolia zeylonica*, Jan. 1906, **3**, Part 11.

The Quartzites of the Bababudan Area, Kadur District.

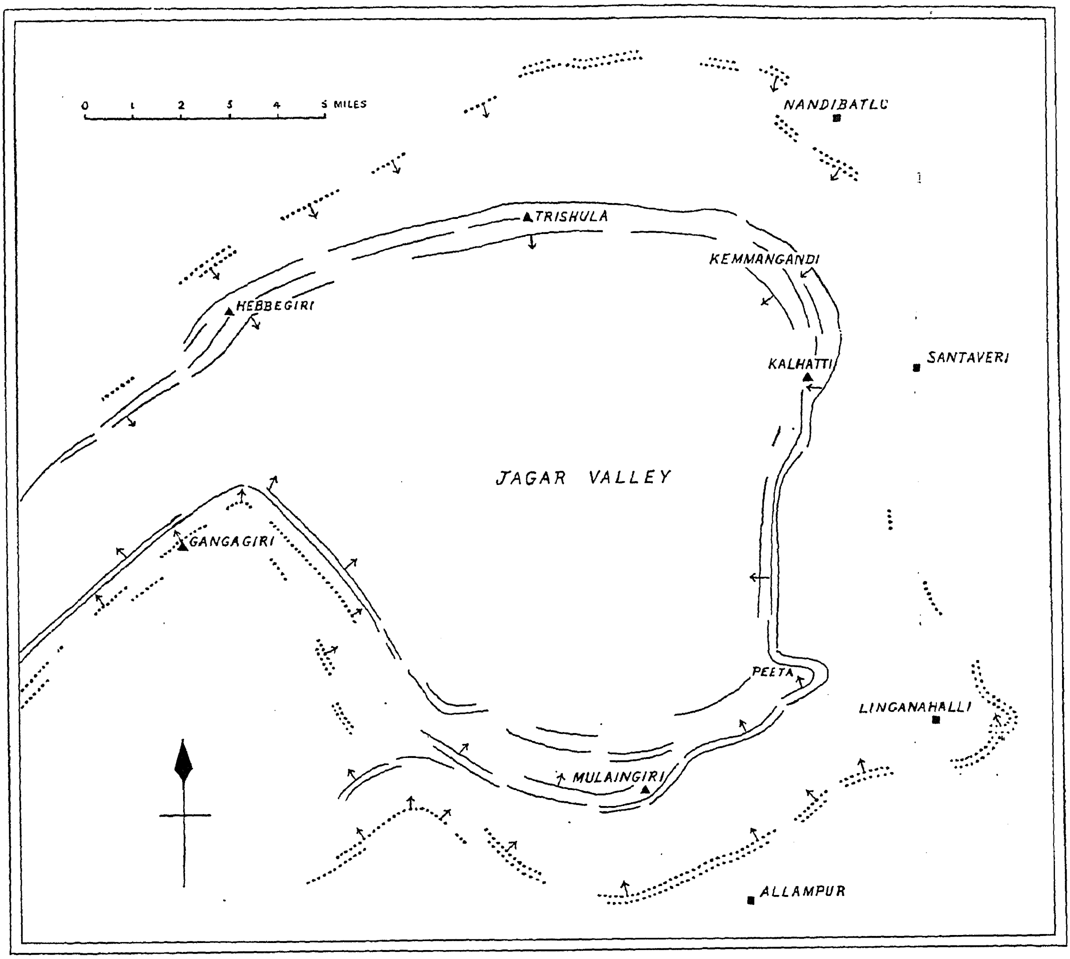
IN referring to the quartzites occurring in the Mysore State, Dr. W. F. Smeeth, one of the former Directors of the Mysore Geological Department, has stated : "There can be little doubt that many of the quartzites are crushed and recrystallised quartz-veins and quartz porphyries, and possibly felsites, and it is at least open to question whether we have any which are genuine sedimentary rocks."[1] In the course of a recent examination of the quartzites occurring in the neighbourhood of the Bababudan ranges, the writer obtained certain evidences which indicate that these quartzites are sedimentary rocks of the nature of sandstones.

The quartzites are generally white in colour, but often they are of various shades of brown. Sometimes they are green, this colour being due to the presence of a green mica. The texture is saccharoidal. The rocks are ordinarily compact but weathered specimens crumble into a granular sand. Under the microscope, the individual grains are often set off by the matrix which is sometimes ferruginous. The grains are not quite uniform in size. In highly crushed varieties, porphyroclasts of quartz occur in a matrix composed of minute grains of quartz, mica and iron ore.

There are several runs of quartzites in the area and brief descriptions of those occurring south of Allampur are given by Bruce Foote,[2] Sampat Iyengar[3] and Balaji Rao.[4] Sampat Iyengar considered that these quartzites were formed by the crushing of quartz reefs.

The runs of quartzite are remarkable in that they follow both in the directions of strike and dip, the banded ferruginous quartzites of the Bababudan ranges, which have been considered by the writer for reasons given elsewhere,[5] to be sedimentary deposits. Fig. 1 is a sketch map giving the main trend lines and directions of dip of the banded ferruginous quartzites, as well as those of the nearest quartzites. It will be seen from this map, that in spite of the discontinuity of the quartzite runs here and there, there is a general parallelism to the banded ferruginous quartzites which have a more or less ring-shaped outline. This agreement in trend is brought out very clearly by the bend in the quartzites near Linganahalli, which closely corresponds to the kink which is noticed in the ferruginous quartzites near the Peeta in the Bababudans.

The quartzites south of Allampur and immediately to the north of Chikmagalur are pebbly in character. The pebbles vary in size from a fraction of an inch to nearly



——— BANDED FERRUGINOUS QUARTZITE ·········· QUARTZITE

(Adapted from the map of Slater and Sampat Iyengar, *Recs. Mys. Geol. Dept.*, Vol. 9.)

Fig. 1.

Sketch map of the Bababudan area showing the parallelism in strike between the banded ferruginous quartzites and the adjoining quartzites. The arrows indicate directions of dip.

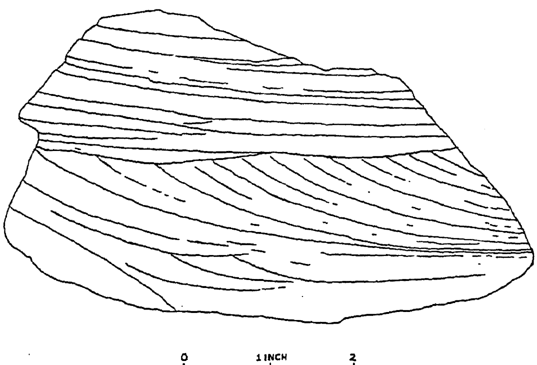


Fig. 2.

Sketch of a hand specimen of quartzite showing cross-bedding.

six inches across. Sampat Iyengar was of the opinion that these rocks were "pseudo-conglomerates," though he has admitted that the rounding of the quartz is so perfect that it could be very easily mistaken for a sandstone. In support of his view, he states: "Two or three of the rounded pebbles have undergone further crushing into smaller pieces so that, at present, the rock section (Z_3661) has assumed the form of a quartzite conglomerate. But the simultaneous extinction under the microscope of three or four rounded pebbles of quartz in close contiguity, give the clue to the crushed nature of the large pieces of quartz."[6] The writer fails to understand how, after pressure

had acted on the pebbles and *rounded* them, they could still preserve their original crystallographic orientation.

The most remarkable feature noticed by the writer in the quartzites is the occurrence of cross-bedding. Very good specimens were collected from the quartzites north of Allampur. Fig. 2 is a sketch of one of the specimens. The bedding planes are seen because of the deposition of ferruginous material along them.

The writer is of opinion that the facts of observation detailed in this note, definitely suggest that the quartzites of the Bababudan area are not of vein origin but are ordinary sedimentary arenaceous rocks.

CHARLES S. PICHAMUTHU.
Department of Geology,
Central College,
Bangalore,
August 26, 1935.

[1] Smeeth, W. F., *Mys. Geol. Dept. Bulletin*, 1916, **6**, 10.
[2] Bruce Foote, R., *Mem. Mys. Geol. Dept.*, 1900, **1**, 37.
[3] Sampat Iyengar, *Rec. Mys. Geol. Dept.*, 1908, **9**, 71-72.
[4] Balaji Rao, B., *Rec. Mys. Geol. Dept.*, 1913, **13**, 139-141.
[5] Pichamuthu, C. S., *Curr. Sci.*, 1935, **3**, 606–608.
[6] Sampat Iyengar, P., *op. cit.*, 72.

Obituary.

Lieut.-Colonel H. W. Acton, C.I.E., I.M.S.

WITH the death of Lieut.-Colonel Hugh W. Acton, C.I.E., I.M.S., there terminates a very brilliant career of medical research work in India, and one of great benefit to this country.

Colonel Acton was a medical student of Middlesex Hospital, London, and before qualifying had carried out special research work on tumours under Sir John Bland Sutton. He entered the Indian Medical Service in 1907, and his first few years in India were spent in military duty,—chiefly on the north-west frontier. Here he made the important discovery that enteric fevers, which at that time were supposed to be of exceptional rarity among Indians, were actually not uncommon in Indian troops.

In 1910 he was posted to the Pasteur Institute of India, Kasauli, as Assistant Director under Lt.-Colonel W. F. Harvey, I.M.S. At that time antirabic treatment in India was in a rather unsatisfactory state. From 1900 to 1907 the Kasauli Institute had used Pasteur's original "dried cord" method, but this was unsatisfactory on account of sepsis and of the introduction into possibly susceptible persons of a large amount of nerve substance, which might lead to "neuroparalytic" accidents. From 1908 to 1911 the dilution method of Högyes was employed ; this was free from sepsis, and the amount of nerve substance injected was minimal, but theoretically at least, the use throughout the course of immunisation of a living rabies virus was not free from risk. Sir David Semple had suggested the use of a (dead) carbolised vaccine, and the years 1910 and 1911 at Kasauli were spent by Colonels Harvey and Acton in testing this out experimentally. Monkeys (*Silenus* or *Macacus rhesus* species) were used in very large numbers ; these had to be first inoculated with rabies "street virus" and then to be inoculated with the carbolised vaccine, and the experiments were carried out at very considerable personal risk to the workers concerned. The result of this work was the introduction in 1912 of Semple's carbolised vaccine, which is to-day in use throughout the Pasteur Institutes of India, and the present efficacy and smooth running of antirabic treatment throughout India is very largely due to the work of Colonels Harvey and Acton. Many years later Colonel Acton suggested the use of sheep instead of rabbits for the "fixed virus", thus again improving results. Whilst these experiments were in progress a "fixed virus" strain was established in the *Macacus rhesus* monkey and it was shown that the Negri body of rabies is of the nature of a cell-inclusion, this work anticipating by many years much of our present-day knowledge of the filterable viruses.

Between 1912 and 1914 Colonel Acton carried out other very important research work at Kasauli. This dealt with latent malaria in dog-bite patients, among whom the sudden change to the cold and altitude of a hill station may often precipitate a relapse of malaria ; with *Hæmoprojeus* infection in pigeons ; with the process of acclimatisation to a hill station altitude and a study of the blood changes concerned. Very important were his studies of snake bite in India. These occupied three years

and were carried out in a very systematic manner. Thousands of experimental animals were utilized—chiefly rats; and some three hundred or more poisonous snakes, the latter being caught by four gangs of professional snake catchers in the Bihar jungles. The chief results of this enquiry were to define with some approach to accuracy the doses injected by the different species of snakes concerned, the relative toxicity of the different venoms, the use of gold chloride as a neutralising reagent, and the necessity for a highly concentrated antivenene. A good resume of the whole subject is given by Colonel Acton in Vol. I of Byam and Archibald's *Practice of Medicine in the Tropics*.

After the outbreak of War in 1914, Colonel Acton was transferred to Simla, as Medical Officer of Health, and subsequently went to Mesopotamia as pathologist and surgical specialist to No. 12, Indian General Hospital at Amara. Here he studied especially the subject of oriental sore, and discovered that the distribution of oriental sores and of sandfly bites on the surface of the body is identical. An important memoir on the subject was published in 1919 and led to the incrimination of *Phlebotomus argentipes* as the vector in India of kala-azar, and of *P. papatasi* and *P. sergenti* as the vectors of oriental sore in north Africa, Palestine and Mesopotamia.

On his return from Mesopotamia, Colonel Acton was posted to the Malaria Convalescent Depôt at Dagshai. This afforded him a unique opportunity for research work on the treatment of malaria. British troops from the different war zones and from all over India were sent to Dagshai in the Simla hills to recuperate. The altitude and the absence of mosquitoes here excluded the possibilities of re-infection, and hence any attack of malaria which occurred was *ipso facto* one of relapse. In a short series of papers Colonel Acton and his colleagues at Dagshai showed: (*a*) that *Plasmodium vivax* is essentially the parasite associated with relapsing malaria; (*b*) that the alkaloids other than quinine in cinchona bark are almost, if not equally as efficacious in the treatment of malaria, so that the very much cheaper treatment with cinchona febrifuge may replace the more expensive quinine treatment; and (*c*) that administration of alkalies greatly enhances the value of the cinchona treatment of malaria. Later Colonel Acton proceeded on deputation to England, where he worked under Sir Henry Dale, at the National Institute for Medical Research at Hampstead on the action of the different cinchona alkaloids on free-living protozoa: the results of this enquiry were to confirm his previous work on the equal efficiency of the different cinchona alkaloids.

In 1921 Colonel Acton became Professor of Pathology, Bacteriology and Helminthology at the Calcutta School of Tropical Medicine, and held this appointment until April 1933. In this appointment he carried out a very large volume of medical research work of a very high order. His work on epidemic dropsy, for example, aroused widespread interest. He showed that the disease was almost always associated with the eating of diseased rice; that rice stored in damp godowns readily became infected with bacilli of the *vulgatus* group; this might cause the formation of soluble toxins in the rice, and when such rice was eaten the absorption of these toxins might cause the symptoms of epidemic dropsy. In very rare instances the patient might acquire an intestinal infection with these organisms, and his stools become infectious to other persons.

Other work, carried out in collaboration with Colonel Chopra, dealt with the toxins of the cholera vibrio;—a subject which is only to-day receiving the close attention which it deserves.

His work in collaboration with Dr. S. Sundar Rao on filariasis was a most notable contribution to tropical medicine. So many and varied are the manifestations of filariasis due to *Wuchereria bancrofti* that at one time the idea was raised that there might be more than one species of worm concerned in India. This view Acton and Sundar Rao showed to be wrong. In heavily endemic areas, such as the Malabar coast, transmission is possible practically the whole year round, the population is constantly being injected with large doses of developing filarial embryos, the superficial lymphatics readily become blocked, and, as a result, elephantiasis is the commonest manifestation of the disease. In slightly endemic areas, such as Calcutta, transmission is only possible for some three months or so of the year; the population receive only small and occasional doses of developing embryos; these are able to make their way rapidly to the deep lymphatics of the pelvis, and in such areas the chief manifestations of the disease are filarial fever,

lymphangitis, chylocele and hydrocele. The lymphatic glands may be blocked in one of two ways; either the worm may die in the gland and obstruct the flow of lymph; or it may cause irritation and inflammation of the gland as it passes through, and superadded sepsis from septic focus anywhere in the body may lead to acute inflammation. Thus the treatment of filariasis resolves itself into the careful examination of the patient for any source of focal sepsis which must be dealt with; the use of autogenous vaccines; and care of the general health. It is not likely that any drug will be discovered which, after injection, will reach the deep lymphatics of the pelvis where the mature worms are lying in sufficient concentration to kill them.

Other research work conducted by Colonel Acton at the Calcutta School of Tropical Medicine dealt with the dysenteries of India: in common with many other workers he found that the incidence of bacillary dysentery in the tropics is very much higher than that of amœbic dysentery. His outstanding contribution to tropical medicine, however, was his study of the skin diseases of the tropics. In 1921 when he commenced his special studies in this subject, it was one of very great confusion. The clinician was describing an ever-increasing variety of new syndromes under new names, whilst the pathologist was constantly discovering new fungi affecting the skin. The great merit of Colonel Acton's work in this subject was that he always searched for the true underlying ætiological agent. Thus a "weeping eczema" of the leg may be due to a streptococcal infection superimposed on a ringworm infection. The best line of treatment for such a condition is not to use irritants; but to use at first soothing applications; then perhaps an autogenous streptococcal vaccine to eliminate the streptococcal infection; then, when the secondary infection has been cleared up, the primary ringworm infection may be dealt with by more drastic remedies.

Colonel Acton's contributions to the subject of "tropical dermatology" were many, and all of them are of importance. He came to occupy almost the (honorary) post of consulting dermatologist to the whole of India. The numbers attending the clinic rose to 12,000 a year. Not only that, he also trained his assistants in methods and technique, and has left as a legacy to the School the only department of medical mycology in India.

Colonel Acton became Director of the Calcutta School of Tropical Medicine in July, 1928. In that appointment he showed not only his genius as a research worker, but his admirable capacity for directing and co-ordinating the work of others. He had an ability to get at the essentials of a research problem, to map out proposed lines of investigation, to suggest technique and procedure, and to assess results, characteristic of genius of a very high order. To-day there is not a department in the School which does not owe a deep debt of gratitude to his powers of organisation and administration.

India will long treasure his memory, for he was the most brilliant of a band of research workers in the Indian Medical Service which is rapidly dwindling in numbers. His life-work will serve as an example to the coming generation, for he gave his best to India with a selfless and devoted generosity.

R. KNOWLES.

Prof. Dr. Emmy Noether.

IN the death of Emmy Noether on 14th April 1935 as the result of an operation, the mathematical world loses one of the foremost investigators in the domain of modern Algebra and an unique and characteristic personality. She was born on 23rd March 1882 as the daughter of the mathematician Max. Noether.

Remarkable as her work was when due consideration is paid to her sex, it is still more remarkable as a contribution to the methods of mathematical thought which she employed in all her work. She was a great apostle of abstract thought and considered no theorem elegant and no proof complete until the inner abstract spirit underlying the ideas was laid bare. She never thought in terms of formulæ but only in concepts and therein lay her great strength. The guiding principle which she actually applied to her work was that no relations between numbers, functions and operations could be considered significant, capable of generalisation and useful unless they were detached from special environments and related to abstract conceptual notions.

It was in the domain of Algebra and Arithmetic that she worked most. She used and enriched the concepts of fields, ideals, modulus and isomorphism by a generalisation of Dedekinds "Modultheorie". Her doctorate dissertation (1907) concerned itself with Gordan's invariant theory in n-ary domain. She soon came under the spell of Hilbert's ideas and did fundamental work in connection with the finiteness theorem and the problem of construction of equations with specified groups.

Emmy Noether can truly be described as the greatest woman mathematician who has done work of such high excellence in the region of abstract mathematical thought.

B. S. M.

Magneto-Chemistry.*

In recent years there has been a great revival of interest in magneto-chemistry, and an extensive series of experimental investigations have been carried out, stimulated by the fact that there is now a sufficient background of adequate theory to enable the significance of the results obtained to be more clearly appreciated. One of the most active workers in the field has been Prof. Bhatnagar, who, with his collaborators at Lahore, has contributed extensively to the progress that has been made.

Although a number of good books have been written on various aspects of magnetism in the last few years, none has been written by a chemist. In the study of the more complex compounds, whether inorganic or organic, a thorough knowledge of the chemical outlook on questions of constitution is necessary in order that the salient points of interest in the results may be brought to light. Prof. Bhatnagar is well fitted to deal with such questions. Further he can approach the general treatment of magnetism with a due appreciation of the kind of presentation which will be of most value to chemists who previously have not studied the more physical and mathematical aspects of the subject. The aim of this book is to place before chemists a comprehensive and at the same time comprehensible account of the experimental and theoretical researches which have been carried out in this field. The authors have been extremely successful in achieving this aim.

Of necessity, if the book was to be a more or less complete whole rather than a chemical supplement, previous books have been freely drawn upon, as is fully and gracefully acknowledged. It is unnecessary to review in detail such parts of the book as present anew such matters as have been dealt with elsewhere. It is sufficient to say that the matter has been well selected, and that in the presentation further points of cognate interest are often noticed, and that where necessary more complete tables of data are given. In indicating the scope of the book, special attention will be directed to those parts which deal more particularly with matters which have not previously been dealt with in detail in book form.

* " Physical Principles and Applications of Magneto-Chemistry." By S. S. Bhatnagar and K. N. Mathur. Pp. xiv + 375. (Macmillan & Co., London, 1935.)

The book opens with a pleasantly written historical introduction, in which mention is made of a reference to the lodestone in the Vedas, and, to skip over intervening millenniums, an appreciative account is given of such earlier theories of magnetism as those of Poisson, Weber and Ewing. The fundamental ideas and definitions are introduced, and an account is given of the usual methods of producing magnetic fields, the large Paris electro-magnet being also described. A brief account of methods of measuring fields follows, particular attention being paid to the convenient fluxmeter method. The theory of susceptibility measurements is given in a sound, if not quite the simplest, form, and a very full account follows of the various types of magnetic balance, including several which are due to Bhatnagar and his pupils. This is probably the fullest account of magnetic balances which has been given, and will provide the intending investigator with a wide choice.

The work of Curie, Honda and Owen, and Pascal is then described under the heading "Pan-Magnetism of Matter". The account of Pascal's work, which, it seems to the reviewer, is seldom sufficiently appreciated, is very detailed and contains a most valuable set of tables of data.

An account is then given of the theory of spectra and atomic structure, based on the original Bohr theory, and the vector model of the atom. It is wise of the authors not to overload their book by entering more fully into the intricacies of quantum mechanics, for the account given here will probably be quite adequate for the chemical experimentalist.

Dia- and para-magnetism are treated in turn : an adequate indication is given of the quantum-mechanical treatment of Van Vleck, and also of the theory of the paramagnetism of free electrons. The account of ferromagnetism is very brief, but it is sufficient to draw attention to the complexities of the problems involved, which fall rather outside the central chemical field.

Magnetism and valency are then considered, the sequence of ideas due to Werner, Kossel, Lewis, Heitler and London, Sidgwick and Pauling being traced. Ionic paramagnetism is taken up again, and here there is some overlapping, but it is not serious, as the questions are discussed from

new points of view, and complex compounds are also considered.

In a chapter on magneto-optics, the Faraday, Cotton-Mouton, Kerr and photomagnetic effects are discussed. Here of particular value is the detailed account given of the magneto optical researches of Perkin, which parallel those of Pascal, and have been too often overlooked.

A summarizing account of the various magneto-mechanical and galvano-magnetic effects occupies the twelfth chapter, which is followed by a chapter on magneto-crystallic action, which is brought well up-to-date. The interesting question of the influence of magnetic fields on chemical reactions is then discussed, and in the final chapter some miscellaneous applications of the use of magnetic properties in physico-chemical investigations are described.

In an epilogue attention is directed to some outstanding problems, such as those connected with the magnetic properties of compounds of transition elements other than those of the iron and rare earth group and the interpretation of the significance of the Pascal constitutive factors, and to the need for more precise measurements of a large number of substances. An appendix includes a useful list of susceptibility values.

It will be clear that the book covers the field in an extremely comprehensive manner. It will be readily comprehensible, and the extensive information it gives, the numerous tables of data, and the lists of references will undoubtedly be of great value, particularly to chemists, not only in showing what has been done, but also in indicating lines of investigation which should be followed up. Prof. Bhatnagar and Dr. Mathur are to be congratulated on having brought to completion so successfully a book which clearly entailed an enormous amount of painstaking work, and so making available to others a detailed survey of the investigations which have been carried out in this wide field.

It remains to add that the book is well-indexed and excellently produced. It is a most useful addition to the literature of magnetism.

EDMOND C. STONER.

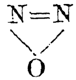
The Structure of Molecules.*

THE latest volume of the collection of works on modern molecular physics, which was edited by Born and Franck, is a book of Dr. H. A. Stuart: *Molekülstruktur*. Like all the other volumes of this series it is meant primarily for the research worker, interested in similar lines. Although a brief account of the wave-mechanical theory of valency and band spectroscopical determinations of the energy of dissociation have been given in the first and last chapters, the main interest of the monograph is not concerned with the electronic configurations of the molecules, but centres round the questions of the arrangements of the nuclei. Here, however, in a branch of knowledge to which the author has contributed to a large extent, particularly by measurements of the Kerr effect, the publication is an extremely reliable and useful guide. In the second chapter the older methods to determine the constants of a molecule are described, such as arise from kinetic theory. A chapter on direct measurements of internuclear distances and valency angles by X-ray spectra and electron interferences, is followed up by a more theoretical presentation on the inner-molecular potential, free rotation and related questions.

The three following chapters particularly will interest most of the readers. The first of them deals with electric polarisation and dipole moment of the molecules and with the structure of the molecules as revealed by the approximately constant moments of the groups. Then follows a chapter on the depolarisation of Tyndall and Raman radiations and the electric Kerr effect which is particularly valuable in determining the anisotropy of the polarisability of a molecule and finally a chapter on infra-red and Raman spectra, by which the vibration frequencies of the nuclei are determined.

In order to see, how these different methods to determine the nuclear structure of a molecule supplement each other, we will consider the results obtained for nitrous oxide, the structure and formula of which were uncertain for a long time. The mere existence of the Raman spectrum excludes from the beginning any electrovalent formula. The Kerr effect excludes a formula

* *Molekülstruktur*, by H. A. Stuart (Verlag von Julius Springer). Pp. 388. Price RM. 33·80.

like  and, since the dipole moment is small but certainly different from 0, a symmetrical formula like N—O—N is not possible. Indeed, infra-red and Raman spectra are in best agreement with the unsymmetric linear formula $N \equiv N = O$, which is confirmed by experiments on electronic interference in N_2O which also indicate a distance of 2·38 A.U. between O and the farther N atom.

This one example may be sufficient to show that it is rarely possible to determine the structure of a molecule by only one experimental method, which describes and seizes only one of its properties, but that all of them have to be taken into account. Dr. Stuart's monograph will be extremely useful to all those who want to compare their own results with those obtained by others by different methods.

R. SAMUEL.

Electro-kinetic Phenomena.*

THE Board of Editors of "The American Chemical Society Monographs" has two objects in view in publishing their excellent series: first, to present the knowledge available upon a chosen topic in a readable form, intelligible to those whose activities may be along a wholly different line and secondly, to promote research in the branch of science covered by the monograph, by furnishing a well-digested survey of the progress already achieved in that field and by indicating fruitful lines along which the investigation might be extended. That both these commendable objects have been achieved in a special degree will be realised by every reader of the monograph on Electrokinetic Phenomena, which presents for the first time important literature scattered through various journals in a connected form.

The phenomenon has been treated from a definitely biological standpoint. The volume includes discussions on organic compounds, blood cells, soils and inorganic materials, and a separate chapter has been devoted to the special aspects of electrokinetic phenomena relating to proteins. Problems connected with the fractionation of proteins from their mixtures are indicated in the section on mixtures of proteins. The applications of this phenomenon in the field of biology and medicine are indicated particularly in the Chapters X and XI which deal with blood-cells, tissues, spermatozoa, bacteria, antibodies, viruses, etc. The selective permeability of living membranes in relation to the electrostatic forces obtaining in the pores of the membrane, which is discussed in the volume, has a close bearing on the introduction, locally, of drugs, the molecules of which are charged.

The fact that isospermatoxins produce loss of sperm motility, leads to the possibility of determining quantitatively the period of immunisation against pregnancy. The influence of such precise physico-chemical control of contraceptive technique should be of more than usual significance. The above two examples of the application of the electrokinetic phenomena, culled out at random from the book, is illustrative of the wide appeal which the volume is entitled to have. The book is written in a style and manner which render it not only exceedingly informative but also most stimulating.

M. S.

* '*Electrokinetic Phenomena.*' By Harold A. Abramson. American Chemical Society Monograph Series No. 66. (The Chemical Catalogue Company Inc., New York.) 1934, pp. 331.

Chronica Botanica.*

FR. VERDOORN has done a great service to the Science of Botany in bringing out *Chronica Botanica*, a useful book of 447 pages. This is mainly a book of information on the progress of Botany in all its aspects pure as well as applied and the author wants to publish it every year. Its success will depend upon the co-operation of the Botanists all over the world.

The book opens with a letter from E. D. Merrill of the New York Botanical Gardens. There is a timely pleading for the International Co-operation among the Botanists. When the spirit of narrow nationalism is running so high it is very gratifying to read this letter. International co-operation has been successfully achieved by Botanists. The plants have no narrow political boundaries. The real co-operation began with the Taxonomists.

In the Almanac for the year 1935 useful information is given of outstanding anniversaries, meetings of International Congresses and Jubilees of various Botanical Institutions.

The detailed programme of the Sixth International Botanical Congress in Amsterdam, 1935, and its Officers occupies nearly ten pages. In the middle of this, a page is set apart for the portraits of eminent Botanists who passed away since the fifth Congress. It is curious that D. H. Scott, the premier paleobotanist, does not find a place here. A special note has been added about John Briquet (1870–1931), a great Taxonomist who rendered invaluable service to Taxonomy and to the success of the International Botanical Congress.

A lucidly written article by A. B. Rendle, F.R.S., on the history of the International Botanical Congress from 1864 to the end of 1930, when the Congress met in Cambridge is of great value for all students of Botany. He shows how the earlier congresses had combined both Horticulture and pure Botany for discussion. From 1900, when the Congress met at Paris the pure Science is having a separate Congress. The second and third Congresses were held in Vienna (1905) and Brussels (1910). Owing to the great catastrophe of 1914–18 the Congress could not meet in London in 1915 and the aftermath of this lasted till 1926 when the Congress met at Ithaca, New York. The 1930 session at Cambridge with Prof. A. C. Seward as President, was a great success and it may be said that the Congress has become a normal annual event.

This is followed by accounts of various International Congresses, Committees and Societies. Useful information for those that are engaged in special fields could be gathered from these. Unfortunately no mention has been made of the Indian Science Congress here.

The succeeding chapter on a Review of all branches of Plant Science during 1934 which occupies the bulk of this publication covers 258 pages. The progress of the Science and personal news are treated in all countries in the alphabetical order, commencing from Afghanistan and ending with Zanzibar. The accounts of persons and matters are of real value. In spite of the earnest appeal from the author, the response has not been adequate. While the technical departments have given useful accounts of the institutions, the Universities have not manifested their co-operation. In India seven out of the seventeen Universities have sent meagre information. It is necessary that all the institutions should send as far as possible a fuller account of their equipment and the investigations carried on or are in progress.

This annual register does not seem to be the proper place for correspondence, however useful the letters may be.

The last 103 pages cover the new and changed addresses of persons, classified advertisements of posts, book-sellers and periodicals. Even the laboratory suppliers find their place here.

A short illustrated History of Botany in the Netherlands has its humourous side.

The book should find a place in every Botanical Institution.

M. A. SAMPATHKUMARAN.

* *Chronica Botanica*, edited by Fr. Verdoorn, Leiden Netherlands, 1935, pp. 447, 15 Neterl. guilders.

Reptilia and Amphibia of British India.*

THE present volume is the second of the four into which Dr. Smith planned to divide the revision of the Reptilian and Amphibian Fauna of British India. The first volume, dealing with the *Loricata* (Crocodilia) and *Testudines* (Chelonia), appeared in March, 1931. The third volume will deal with the Snakes, and the fourth with the Amphibians. Both the volumes so far published mark a decided improvement over Boulenger's work "Reptilia and Batrachia" 1890, in this series.

As mentioned by the author in his preface to the First Volume, the region dealt with is not precisely that forming the scope of Boulenger's work, but "has been extended to include the whole of the Indo-Chinese sub-region, and is almost the same area as that included by Günther in his "Reptiles of British India," 1864. This extension in the limits of the area dealt with is due to the fact that the fauna of Siam, French Indo-China and Southern China is so closely allied to that of Burma that the author feels it to be scientifically incorrect to separate the two from each other. We trust that the change is for the better, as it makes it possible to avoid the artificial division of this natural sub-region and to consider it as a *whole*. Altogether, the volume on *Sauria* (Lizards) describes 297 species, of which 248 occur in the Indian Empire; while Boulenger's work (1890) contained descriptions of 226 species of Lizards (including also the Chamæleon), of which 17 were "included upon incorrect data or have since been placed as synonyms". This means that Dr. Smith's volume contains the descriptions of 39 more species than Boulenger's.

As in his descriptions of the orders *Loricata* and *Testudines* in the First Volume, the author begins his work on *Sauria* with an illuminating general Introduction, which deals with Structure, Evolution, Devolution, Geographical Distribution, Economics, and Preservation and Examination of Specimens. Dr. Smith possesses the knack of clear and concise expression and he has, in this Introduction, condensed a great deal of scientific knowledge about this group of reptiles. In the section on Evolution and Devolution, he gives a valuable account of the evolution of the adhesive digital pad and the external coverings of the eye, as also of the degeneration of the eye, the ear and the limbs. The remarks in this section, as pointed out in the preface, are the "outcome of the study of the structure of the Indian and Indo-Chinese species". But the author assures us (pp. v, vi) that he has carried out his researches much further afield and has studied the whole group from this standpoint. We look forward eagerly to a fuller account of these problems.

About *femoral glands or organs* (p. 4), the author says, "They are not true glands, but tubular invaginations of the epithelium, the opening of which, termed the pore, may perforate a scale or lie between two or more scales." We are not in a position either to endorse or to refute the author's verdict that these are not really glands; but certainly there are a great many workers who have investigated these structures and are inclined to regard them as glands. Camp (1923)[1] gives an excellent résumé of the work done in this direction, and says: "Duvernoy, Wagler (1830),[2] and Johannes Muller first noted the glandular nature of the femoral organs. The histology has been investigated by Leydig (1872), Schæfer (1902),[3] Cohn (1904),[4] Tölg (1903),[5] Félizet (1911)[6] and others. Félizet remarks upon the similarities with the mammalian sebaceous gland....... This was also partly the view of Meissner (1832),[7] Leydig, and Schæfer, and many later workers....... Maurer....believed that the proximity of lymph spaces indicated a similarity to the musk glands of crocodiles..... The glands

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* *Fauna of British India including Ceylon and Burma.* (*Reptilia and Amphibia*). Vol. II. *Sauria.* By Malcolm A. Smith. (Taylor and Francis, London). 1935. Pp. xiii+440, 93 text-figures, 3 plates and 2 maps. Price 30*s*.

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[1] Camp, C. L., "Classification of the Lizards," *Bull. Amer. Mus. Nat. Hist.*, 1923, **48,** 401-403.

[2] Wagler, J., "Natürliches System der Amphibien, mit vorangehender Classification der Säugehiere un Vögel," *Ein Beitrag zur vergleichenden Zoologie*, München, Stuttgart and Tübingen, 1830.

[3] Schæfer, F., "Ueber die Schenkeldrüsen der Eidechsen," *Archiv für Naturgeschichte*, 1902, **68,** Band I, 27-64.

[4] Cohn, L., "Die Schenkeldrüsen des *Cnemidophorus lemniscatus* Daud," *Zoo. Anz.*, 1904, **27,** 185-192.

[5] Tölg, F., "Beiträge zur Kentniss drüsenartiger Epidermoidalorgane der Eidechsen," *Arbeiten Zoolog. Inst. Wien*, 1905, **15,** 119-154.

[6] Félizet, J., "Recherches sur le Glandes Fémorales de *Lacerta muralis*," *Journ. d'Anat. Physiol.*, 1911, **47,** 333-370.

[7] Meissner, C. F., "Die Amphiborum quorandum Papillis Glandulisque Femoralibus," 1832, Basel.

are seemingly of functional significance and not vestigial or rudimentary structures."

As regards the evolution of the *external coverings of the eye* (p. 9), the author believes that "the simplest form of eye-covering is to be found in the Geckoes" and that this type has given rise to others by "the disappearance of the immovable transparent disc, its function as a covering for the eye being now undertaken by the eyelids. Whether it becomes thinned and so disappears, or whether it becomes united with the cornea," he is "unable to say". May we point out that some zoologists (*e.g.*, Johnson, 1927),[8] who have given thought to this problem, regard the gecko type of eye-covering as not simple, but specialised, due to an "excessive development and specialisation of the nictitans, which becomes quite transparent"?

Besides the Introduction, the volume on *Sauria* contains excellent systematic descriptions of the sub-order, families, genera and species of the region dealt with; complete synonymies of not only the generic and specific names, but also of those of the families and the sub-order; a glossary and general index; and a fairly complete bibliography. The author has examined the types of almost all the species mentioned and has taken great pains to make the work as authoritative and helpful as possible. He has followed the law of priority in nomenclature rather rigidly, and has carried it "into all groups, although the Rules of Zoological Nomenclature do not, at present, require it to be carried higher than genera". For our part, we doubt the utility of changing the nomenclature of zoological classification at the cost of common usage, especially in the case of groups higher than genera and species.

In going through the Bibliography, one observes the omission of several important papers, referred to in the text. One looks in vain, for example, for the papers of Weekes, 1929 and 1930 (referred to on p. 6 of the volume), Hingston, 1933 (the same page), Hewitt, 1929 (referred to on p. 3), etc. Much of the value of a work like the present one lies in directing our attention to the original contributions on the subject and we hope that Dr. Smith would give a more complete list of references in the coming volumes on Snakes and Amphibians.

Boulenger (1890) in his volume on "Reptilio and Banrachio" preferred to divide Lizards into two sub-orders: *Lacertilia* and *Rhiptoglossa*, the latter consisting of a single family, *Chamæleotidæ*. Dr. Smith, however, includes *Chamæleotidæ* along with the other Indian families of Lizards in the same synopsis (pp. 20–21) and places this family just after *Agamidæ*. This is in accordance with Cope's opinion that the Chamæleons are related to the Agamids, an opinion confirmed by Camp (1923).[9]

One might mention, perhaps, that in the case of one genus at least (*Hemidactylus*) no mention of the size and nature of eggs is made even though we have some records about them. Baini Parshad's article on *H. flaviviridis* (*Jour. Bom. Nat. Hist. Soc.*, 1916, **24**, pp. 834–838) has, apparently, not been available. It would probably be better also to have the glossary of each volume as complete as possible, irrespective of the fact that some terms have been explained in a previous volume. Such a procedure would make each volume of this series so independent of others as to make reference by a layman really easy and would facilitate his understanding of the common terms used in the text to a considerable extent.

Dr. Smith is a well-known herpetologist, and we are sure that his present work is really the best introduction so far published to the systematic study of Indian Lizards. He has produced a volume of decidedly high order, and Indian zoologists should be particularly grateful to him for it.

B. C. M.

[8] Johnson, G. L., "Contributions to the Comparative Anatomy of the Reptilian and the Amphibian Eye, chiefly based on Ophthalmological Examination," *Phil. Trans. Roy. Soc.*, 1927, **B 215**, 319-320.

[9] Camp, C. L., *op. cit.*, 333.

Research on Lac in Great Britain.

IT is two years since the Indian Lac Cess Committee deputed three research workers to England to carry out a scheme of research in the industrial uses of lac, in the fields of the paints and varnishes, the plastics and the electrical industries. In the preface to the first technical paper, Dr. Jordan refers to the several lines of investigation being pursued concurrently and the first bulletin deals with the isolation of the Pure Lac Resin, the economics of whose isolation and utilisation must, for the moment, remain an unsettled question. The paper by Dr. Bhattacharya and Dr. Verman on this subject of isolation of pure resin is a very valuable contribution which promises to find application in technological development of lac. Dr. Verman has discussed the industrial possibilities of pure lac resin, in a paper read at a joint meeting of the London section of the Plastics Group. The most hopeful application of the lac resin, which Dr. Verman has indicated, is in the manufacture of an insulating varnish for wire, which should be able to withstand elevated temperatures for long periods of time. The pure resin has a quicker rate of hardening than the original lac and this circumstance should extend the employment of the pure lac resin to regions where the "slow hardening" of untreated lac has been found defective. Another application of great promise is the manufacture of canning aluminium and tin foil lacquers. Experiments have shown that with pure lac resin, can be successfully made coloured lacquers, having good adhesion and non-sticky. Yet another possibility which Dr. Verman has indicated is the employment of the pure resin for electric insulating moulding. The chief difficulty in shellac moulding at the moment is the slow rate of heat-hardening and any process through which the time of hardening could be reduced, will be considered a useful technological development. Properties of the pure lac resin in this respect have not been investigated except to show that it possesses a quicker rate of hardening than shellac; with the addition of accelerators it may be possible to reduce further the time of hardening and in this direction we shall await with keen interest the results of Drs. Bhattacharya and Verman.

One pauses to reflect if all this work detailed above could not have been done in India at the Lac Research Institute at Ranchi or at the Indian Institute of Science, Bangalore. It is true both these Institutes have to a large extent pioneered researches on the various aspects of lac but what has been sadly lacking with respect to both of them is that close contact with the consuming industries, which have always been responsible for stimulating applied research. The Indian research workers who have now been stationed at the Paint Research Station at Teddington, have the enviable opportunity of facing the practical problems of the industry understanding their needs and meeting their exacting requirements through research. They have done well indeed but the Indian Lac Industry expects more work from them, if it should escape the crisis.

M. S.

Alchemy in China.

IN an interesting article appearing in *Nature* (1935, **136**, 287-88), Prof. J. R. Partington gives an accouut of an ancient Chinese Treatise on Alchemy, an obscure and mystic work of considerable historic importance. The treatise is *Ts'an T'ung Ch'i* of Wei Po Yang who flourished in the 2nd century A.D., and was called the 'father of Chinese alchemy'. This treatise has been recently translated by Dr. Lu Ch'iang Wu and annotated by Prof. Tenny L. Davies. The translation is a task of no small difficulty from which, the previous sinologists had turned away in despair. The treatise has been considered to be the earliest, in Chinese language. From the references to earlier Chinese alchemists it is reasonable to assume that for at least 2 or 3 centuries before Wei Po Yang, attempts to transmute base metals into gold and prepare elixirs of life were being made and alchemy in China and Greece was contemporary. "Dr. Wu and Prof. Davies are to publish later some alchemical chapters from Ko Hung, a celebrated Chinese Taoist Philosopher and Alchemist of the fourth century and the history of chemistry will be enriched by their work."

Research Notes.

Variation of the Mass of an Electron with its Velocity.

As is well known there are two theories of the electron leading to different expressions for the dependence of the mass on the velocity, namely the theories of Abraham and of Lorentz, the result of the latter agreeing with that of the Relativity Theory. Bucherer's experiments are taken to provide evidence for the correctness of the theory of Lorentz as against that of Abraham, but the accuracy of the experiments is not sufficient to accept them as conclusive. Sommerfeld's theory of the fine structure of hydrogen lines provides an indirect proof of the correctness of the Lorentz formula. However, a direct experimental proof was a desideratum and one is now provided by the experiments of M. Nacken described in *Annalen der Physik*, 1935, **23**, 313. Nacken has used cathode ray electrons accelerated through 200 kilovolts and 7 kilovolts respectively so that there was an advantage over using the β-rays from various sources in that the intensity of the beam could be increased and sharper lines could be obtained with shorter exposures. The cathode rays are deflected by electric and magnetic fields: there is however an improvement in that the electrons of 7 kv. and 200 kv. are made to trace the same path by adjusting the strengths of the electric and magnetic fields so that errors due to the geometry of the apparatus do not appear in the calculations. If J and J′ are the currents in the magnetic field-coils and V and V′ the potentials between the condenser plates required to produce the same deflection in the 200 kv. and 7 kv. electrons respectively and $\beta = 0 \cdot 161 \dfrac{V/V'}{J/J'}$ then if μ and μ_0 are the masses of the two groups of electrons, $\dfrac{\mu}{\mu_0} \dfrac{\beta}{J/J'}$ = a constant = 0·166 according to Lorentz's theory but slightly variable and equal to 0·154, 0·153, 0·153, 0·152 and 0·150 under the experimental conditions used by Nacken. The actual values obtained for this quantity were 0·166, 0·165, 0·164, and 0·162 with a mean of 0·164 while the error in determining J/J′ might be 0·7% and that in V/V′ could be 0·6%. Since the results to be expected according to Abraham's theory differ from the experimental values by 6·1 %, 7% and 8·5% while the deviation of the mean result from Lorentz's theory is only 1·2%, Nacken concludes that his results decide definitely in favour of the theory of Lorentz.

T. S. S.

The Velocity of Light in a Partial Vacuum.

THE late A. A. Michelson had made arrangements to determine the velocity of light in vacuum but his death prevented his concluding the work. F. G. Pease and F. Pearson who were associated with him in this work have carried it on to a successful conclusion and an account of the results so far obtained is given in *Astrophysical Journal*, 1935, **82**, 26. The method used was that of the rotating mirror having 8 and 16 faces and the light travelled to and fro inside a steel pipe line, one mile long and evacuated to a pressure varying from 0·5 mm. to 5·5 mm. of mercury. The details of this stupendous undertaking are illustrated by beautiful photographs. The light-path used varied from 8 to 10 miles. The distance was accurately measured by comparison with a carefully measured base-line set up near the pipe line. The number of revolutions per second made by the mirror was correctly determined by strobscopic observation of a tuning fork synchronised with the rotating mirror, the tuning fork being compared with a freely swinging pendulum which was compared with a chronometer which in its turn was rated by means of time signals from Arlington. "2885·5" determinations of the velocity were made during a number of years and the mean value obtained for the velocity of light was 299774 km. per sec., the average deviation from the mean being 11 km./sec. As Birge has pointed out (*Nature*, 1934, **134**, 771), this result agrees with the values obtained by Mittelstædt (1928), Mercier (1923) and Rosa and Dorsey (1906) using other methods, and so the variation of the velocity of light postulated by Gheury de Bray and Edmondson may be only apparently confirmed by the measurements employing long base-lines.

T. S. S.

Photo-Oxidation in Near Infra-Red.

IN the photo-oxidation of organic substances in presence of chlorophyl, under favourable conditions one molecule of oxygen is absorbed per quantum of absorbed light, irrespective of the wavelength. If the

wavelength of the incident light is continuously increased, for any given substance, there will be a limit beyond which the absorbed quantum will be insufficient for the activation energy required for oxidation. This, in principle, simple method for determining the activation energy for autoxidation of organic substances, however, requires a dyestuff which absorbs in the red and infra-red, and also a filter that transmits in these regions. Chlorophyl is not suited for this purpose as it does not absorb even in the visible red region. H. Gaffron (*Berichte*, 1935, **68**, 1409) has discovered in Bakterio-chlorophyl (extracted from *thiocystis*) a suitable dyestuff for this purpose. A solution of this in acetone, containing thiosinamine as acceptor absorbs oxygen when irradiated with light even beyond 760 $\mu\mu$. This observation settles that it is not the oxygen that is activated by the sensitised dyestuff—as has been postulated by some, —since the energy required for the activation of oxygen to $^1\Sigma$ state is 37000 cal. corresponding to 762 $\mu\mu$, and thus light of longer wavelength would be ineffective.

M. A. G.

Inter-Molecular Forces in the Liquid State.

P. GIRARD AND P. ABADIE (*J. de Physique*, 1935, **7**, 295) have reported an interesting observation that the time of relaxation of a polar molecule in the liquid state, is extremely sensitive to the inter-molecular forces. Although Debye's theory of dispersion of dielectric constants is not strictly applicable to the pure liquid state, from the observed dispersion data, the characteristic period of relaxation τ can be evaluated by choosing a proper value for a in $\tau = \frac{4\pi\eta a^3}{T}$, where η is the viscosity of the liquid, T the absolute temperature and a is a constant having the dimension of molecular radius. This value of a gives a direct measure of τ after allowing for the influence of η and T. A comparison of the values of a shows, contrary to expectation, that the time of relaxation for different polar molecules in the liquid state varies *inversely* as the polarity of the molecule. By a process of elimination, it has been deduced that this remarkable relation must be attributed to the inter-dipolar forces prevailing in the liquid state. This is confirmed by the observation that when the polar liquids are diluted by non-polar solvents, the relaxation time increases to a maximum value of 3 to 7 times the original value, and then decreases. The nature of this curve would seem to indicate that the inter-molecular forces can have both effects, *viz.*, to increase or to decrease the time of relaxation according to conditions. It is briefly indicated that such effects can be attributed to the structure of the liquid state resembling more closely the crystalline state than the gaseous one.

M. A. G.

The Range of Action of Surface Forces.

BASTOW AND BOWDEN (*Proc. Roy. Soc.* (A), 1935, **151**, 220) have made viscosity measurements of thin liquid films, which throw light on the state of the liquid molecules in the neighbourhood of a solid surface. The results show that the solution of a liquid crystal has pronounced rigidity ; but no such effect is observed with normal liquids such as water, alcohol, acetic acid, etc., even in the neighbourhood of the freezing point. Furthermore, acetic acid shows a normal behaviour while it is in the supercooled state —a state in which there is comparatively high probability for the formation of the multimolecular layers. The results negate the conclusion of certain workers that there could be induced rigid structures of molecules extending from a surface to a distance of 1500 Å to 50000 Å. The length of such oriented structures, if they exist, is certainly less than 1000 Å and probably very much less.

K. S. G. D.

The Influence of the Electrode Surface on Anodic Reactions.

THE mechanism of the anodic oxidation of compounds at different electrode surfaces is of considerable practical and theoretical significance. Glasstone and Hickling (*J.C.S.*, 1934, 1878) have recently advanced the view that hydrogen peroxide is formed as a primary reaction product on the surface of the anode. This has been seriously questioned by Walker and Weiss in a recent paper (*Trans. Far. Soc.*, 1935, **31**, 1011). They have adduced definite evidence to the non-formation of hydrogen peroxide. The formation of oxide films which change the nature of the anode surface has however been detected. From the standpoint of quantum mechanics, there is a potential barrier between the electrode and the reacting

ions round it, which are in an adsorbed condition. It has been shown that for the discharge of an anion at the anode, the following relation should be satisfied.

$$\phi + V_a > E_{ion} + H_{ion} - \Delta A$$

where ϕ is the work function of the metal electrode, V_a the applied anode potential, E_{ion} the electron affinity of the adsorbed anion, H_{ion} the hydration energy of the anion and ΔA the adsorption energy of the process. In the above relation, both ϕ and ΔA depend upon the properties of the surface. Anodes with high Oxygen over-voltage (*e.g.*, Smooth platinum) favour the primary deposition of the anion, since the electron affinity of other anions is lower than OH^-. In the case of electrodes with low over-voltage (platinised platinum, metallic oxides), the primary discharge of the hydroxyl radicle may take part in the chemical oxidations on the anode.

M. P. V.

Study of Evaporation of Water from a Soil Surface.

THE dependence of fluctuations of water table on the surface evaporation and atmospheric pressure was investigated by Vaidhianathan and Luthra (*Research Publication*, November 1934, **5**, No. 3, Punjab Irrigation Res. Inst.) at Lahore during June, the hottest part of the year. Surface evaporation was studied for 11 days by exposing P_2O_5 in shallow bottles kept under a bell jar, while the fluctuation of water-table was studied by means of observation pipes fitted with strainers. It was found that while pressure has an effect on the fluctuation of the level of the water table, when the surface evaporation is high, however, the fluctuations of water table and pressure became out of phase and evaporation became the most predominating factor. The conclusions of the previous workers made in Australia and elsewhere that pressure is the main factor effecting the water table do not apply to the conditions existing in Lahore. It was found that there is continuity in the moisture content of the soil between the water table and the surface even though the water table is at a depth of 22 feet below the surface indicating that the water lost by evaporation is being continually replenished from the ground water level. This is in contradiction to Keen's observations made at Rothamsted that water which receded 6 ft. is not drawn up by surface evaporation. The amount of water evaporating from the surface was found to be $2 \cdot 7 \times 10^{-7}$grs. per sq. cm. per sec. on the average for June, when the maximum temperature was 66° C.

A Statistical Examination of the Uplift Pressure Data obtained from Model Experiments.

A NUMERICAL estimate has been made of the "Experimental Error" involved in the data obtained from model experiments to determine uplift pressures by Malhotra and Uppal (*Research Publication*, Jan. 1935, **1**, No. 5, Punjab Irrigation Res. Inst.). Attention was confined to the variations of "percentage drop of pressure" at individual pipes, the observations being taken from the same model though the head was varied. 97 individual pipes were used for each set of observations and they have been classified into 6 groups depending upon the experimental conditions. Eliminations due to choking and other causes have been made of some individual pipes. The analysis of variance due to Fisher was applied to the figures for "percentage drop of pressure". It was found (i) "that the upper limit of the 'Experimental Error' for any group of observations is less than 0·50" and (ii) that "all but about 1 per cent. of the observations would fit into a range of 3E on either side of the mean value for the pipe"; (iii) "In only one case 3E was as high as 1·5 and in all other cases it is less than 1·0"; and (iv) "An increase in the dimensions of the model did not affect the magnitude of the error."

Oil Formation in the Groundnut.

THE preference accorded to Indian groundnuts in the British market under the Ottawa Agreement is considerably neutralised by the poor quality of the Indian nuts as evidenced by the high free fatty acid content of the consignments from this country, the nuts from the Coromandel Coast ports being particularly bad in contrast with those from the West Coast ports, Mormugao and Bombay. An investigation into the causes affecting the quality of the groundnut has been undertaken by J. J. Patel and C. R. Sheshadri and the results of a study of the rate of oil formation and the effect of early harvest on the oil content are published (*Indian J. of Agr. Sci.*, 1935, **5**, Part II). There is, throughout the period of development of the seed, a gradual and uniform

gain in the oil content and reduction in the free fatty acid content. The harvest of groundnut even one week before the kernels are fully ripe increases the free fatty acid content and reduces the oil content by about five per cent. Premature harvest is thus suggested as one of the causes of low quality. The other effects of such early harvesting such as the high moisture content and the need for prolonged drying and deterioration by fermentation are being studied.

A. K. Y.

Factors affecting the Absorption of Selenium from Soils by Plants.

ANNIE M. HURD-KARRER records the results of further studies on the toxicity of selenium to plants, now that the subject of this toxicity has assumed importance, owing to the fact recently established that this toxicity is communicated to animals growing on such vegetation (*J. Agri. Res.*, 1930, **50,** No. 5). The work relates to pot culture studies conducted with two different kinds of soils "the Keyport clay loam" and "Pierre clay". Of the 17 different kinds of plants grown, the cruciferæ mustard and Broccoli absorbed the largest quantities, 1240 and 1180 parts per million respectively, while at the other extreme come the grain crops, and about midway the other crops, *viz.*, sunflower, flax, sweet-clover, alfalfa pea and spinach. The cruciferæ showed no outward signs of suffering or abnormality though they absorbed the largest quantities, while the gramineæ generally suffered most, the intermediate class remaining normal with the exception of the sunflower. The factors affecting the absorption by wheat of selenium added as sodium selenate to the soil and the resulting toxicity to this crop are summarised as available sulphur, soil type, percentage of sand, method of adding selenium, the form of selenium added and the growth of previous crops. It is suggested that the tendency of a crop to absorb selenium depends on its tendency to absorb sulphur, as in the case of the cruciferæ. Sodium selenate is absorbed by wheat more in the Pierre clay than in the Keyport clay loam. Applications of free sulphur reduce the absorption by wheat of the naturally occurring selenium in soils as well as that added as sodium selenate. Gypsum is similarly effective. The addition of quartz sand to Keyport clay loam increases the toxicity of the selenate in proportion to the percentage of sand. Sodium selenate is not easily leached and is partially retained in the upper layers. Elemental selenium is apparently unavailable and non-toxic to wheat at least in quantities up to 200 parts per million in Keyport clay loams. The selenium was more toxic in the form of sodium selenate than in the form of selenite. Sodium selenate was either changed to a less toxic form or reduced to a sub-toxic concentration by the growth of successive crops of wheat.

A. K. Y.

The Duration of Life in an Albino Rat Population.

B. P. WILSON AND N. M. SHEARD (*Proc. Roy. Soc. Edin.*, **55**, Pt. 1) have, for the purpose of presenting the data on the life span of the albino rat, divided its life into two phases. The first phase comprises the span of life spent by the rat in greater or less dependence on its mother; this phase ends during the fourth week post partum. The second phase comprises life after weaning. During the period following weaning very few animals died under the conditions in which they were maintained.

Data relating to 250 litters chosen at random are presented where the total number of young in these litters was 1,607. Of these a total of 492 animals died, or were killed by their mothers before the age of 30 days; while 1,115 survived upto or beyond this age. This would correspond to a death rate during this first phase of about 30 per cent. It was found difficult to establish in any given case whether death of either a litter or a single young was due to low vitality or to accidents such as cannibalism or squashing of young by the mother because the latter fails to assume the appropriate "nursing posture". These factors were eliminated when once the young was separated from their parents. It has been shown that not only is the mean duration of life shorter in males but the terminal age reached by females exceeds the terminal age of males. The force of mortality rises after the ninth month of life in geometrical progression.

Foetal Respiration.

J. BARCROFT'S Croonian Address on Fœtal Respiration (*Proc. Roy. Soc. Lond.*, 1935, **118** (B), No. 808), attempts to state the principal facts known about the subject in the Mammalia. Needless to say that the

respiratory system goes hand in hand with that of the circulatory system. The umbilical arteries convey blood deficient in oxygen to the placenta, while the richer blood returns to the inferior vena cava by means of the umbilical veins. It is pointed out that the volume of blood passing through the fœtal heart and the oxygen consumption of the fœtus bear a relation to the weight of the fœtus itself, though in the case of the rabbit, the placenta reaches its maximum size before the culmination of the progressive growth of the fœtus. And on account of the rise in arterial pressure, more blood passes through the fully grown vascular bed in the placenta. Moreover the oxygen utilised by the fœtus bears a constant relation to the weight of the fœtus over last half of fœtal life. Towards the end of pregnancy the relationship stands thus: On the fœtal side a rapidly growing fœtus with a fœtal irrigation of the placenta and the consumption of oxygen with reference to the weight of the fœtus is present while on the maternal side neither the blood flow nor the size of the placenta increases. Therefore the "Oxygen difference" between the blood in the umbilical artery and vein should be the same whilst the maternal blood leaves the uterus increasingly reduced as pregnancy advances. That this is so is clearly shown by the dark blood emerging from the pregnant side of the uterus of the rabbit, and as regards the oxygen difference, the factors involved in this are that "the oxygen breaks away from the hæmoglobin of the mother, becomes dissolved in the plasma of the maternal blood and attains a certain partial pressure in that plasma. It then diffuses to the plasma of the fœtal blood in which it necessarily exists at a lower pressure than that which it set up in the plasma of the mother. The oxygen then passes to the hæmoglobin which it saturates up to whatever point may be possible at the partial pressure in question." Further it has also been noted that "the placental membrane is incapable of maintaining any considerable difference of pH between the maternal and fœtal plasma and that the hæmoglobin of the fœtus is different from that of the mother. Regarding the passage of blood in fœtus it has been long known that most of the arterial blood arriving by the inferior vena cava enters the left ventricle after passing through the foramen ovule into the left auricle; from the ventricle a large part enters the carotids and proceeds to the head region. The blood from superior vena cava enters the right ventricle through the right auricle; from the ventricle the blood is projected through the ductus arteriosus into the aorta and the mixed blood passes to the body. Of the 300 c.c. of blood which traverses the fœtal heart, about 150 c.c. goes to the head and other 150 c.c. to the abdominal aorta; of the latter 150 c.c. perhaps 100 c.c. goes to the placenta for aeration and 50 c.c. to the body of the fœtus for the nourishment of the same." Thus a great volume of blood finds its way through the ductus arteriosus but how this flow is stopped at the time of birth is left unanswered since it is purely a post-natal problem.

The Charnockite Series of Uganda, British East Africa.

EVER since Sir Thomas Holland recognised the Charnockite series in India as intrusive plutonic rocks, similar members have been studied in other areas, but still the origin of such rocks has not been finally determined. Some petrologists believe that charnockites are the result of assimilation of argillaceous sediments, while others like Vredengurg hold that metamorphism alone is responsible for the formation of such a group of rocks ranging from acid to ultra-basic with a uniformity of character. Adams who studied the charnockite rocks of Ceylon could not come to any definite conclusions. A comprehensive study of the charnockites from Uganda, British East Africa, has been made recently by A. W. Groves (*Q.J.G.S.*, **91**, No. 362). His study includes many chemical analyses, comparison with similar rocks in other areas, especially in India, and a detailed study of the development of Hypersthene. At the end of his paper he has tabulated a series of arguments to show that the charnockites do not result from the assimilation of sediments by magmas. The marked presence of "dry minerals," universality of secondary characters, linear arrangement of minerals and "the appearance of successive ferromagnesian minerals in the reverse of the accepted order for plutonic rocks of the calc-alkali series" have led him to conclude that the charnockites of the Uganda series of rocks are the result of plutonic metamorphism of normal igneous rocks. In view of such a conclusion by Groves, it is desirable to review the study of Indian charnockites to aid their correlation with similar rocks occurring in distant parts of the globe.

The Correlation of the Pre-Cambrian Granites by means of Heavy Mineral Analyses.

In many localities correlation of isolated outcrops of igneous rocks by thin sections and field studies are beset with numerous difficulties. In recent times such obstacles have been overcome to a certain extent by the study of the heavy mineral analyses, and in most cases successful correlations have been established. J. T. Stark and F. F. Barnes (*Geological Mag.*, 1935, No. 854) during the course of their study of the closely related Pikes Peak and Silver Plume Granites of the Pre-Cambrian Age in the Sawatch Range of Central Colorado have shown by means of the heavy mineral analyses that outcrops belonging to the two series of granites differ fundamentally, in their heavy mineral constituents. In the Silver Plume granite there is a large percentage of Zircon, while the Pikes Peak granite is characterised by a large percentage of Titanite. By a series of curves they have shown that though there are a large number of minerals common to both the series of granites yet the relative proportions of certain of the important minerals like Zircon and Titanite are sufficiently marked for being made use of in correlation.

Sugar Industry of India, 1933—34.*

The year 1933–34 was one of general depression in the sugar industry of the world. The total production of sugar during that year exceeded the consumption by about 740,000 tons. But mainly as a result of protective tariffs, the Indian sugar market did not suffer any dislocation and on the other hand accommodated the produce of 112 factories which operated during that year. There was a marked decline in the total sugar imports into India. On the cultivation side, though the acreage under cane was less than in 1932, the cane grown exceeded the figure for that year in consequence of the increasing adoption of improved varieties of cane. The severe earthquake in Bihar on 15th January 1934 was responsible for a large damage to the cane crop. The factories designed to work were 123 during 1933–34 but only 112 were in operation. The total produce was 453,965 tons which was 163,788 tons more than the produce of 1932–33. In spite of a large number of new factories working and the loss in Bihar due to earthquake, the average recovery for the whole of India showed a slight increase over the previous year's figure.

Advancement in technical and scientific work was not lacking. The research stations in Coimbatore and Pusa and those in other provinces demonstrated the increasing usefulness of many Coimbatore varieties of cane which are rapidly ousting the local varieties out of cultivation. Financed by the Imperial Council of Agricultural Research the work on the design of a small power-driven mill started in 1931 resulted in success and the mill was standardised for cane conditions in Bihar and Orissa.

Of great importance to Indian Sugar Industry are the Government of India Acts Nos. XIV and XV of 1934 which provide for the levy of an excise duty of factory sugar and empower local governments to restrict sugarcane dealings and fix cane prices in such a manner as to secure to the growers a fair price for their produce.

The total value of sugar machinery imported into India during 1933–34 was Rs. 3.36 crores of which nearly Rs. 2 crores were spent on British machinery alone. The import of machinery in 1932 was only half of this value.

Besides the 453,965 tons of sugar made in factories direct from cane, 225,000 tons were produced by indigenous process and 60,000 tons by refineries making a total production of 738,965 tons. Consequent to this large production there was also a sharp fall in the quantity of imported sugar. Gur production in 1933–34 was 10.8 per cent. higher than in the previous year with a corresponding fall in molasses imports.

The position of sugar trade of Java and Cuba is of interest. Java suffered enormous fall in her sugar exports owing to severe competition from other countries and the large increase in the production of British India. Under the management of sales by the 'NIVAS', quantities of sugar in excess of the production of 1933–34 were disposed of. During the year under review only 99 factories operated in Java as against 166 in the preceding year. The acreage under cane was only 208,947 in 1933–34 as against 423,924 in 1932. The Cuban sugar trade of 1933 was influenced considerably by the inflationary policy of the U.S. Government, the attempt at the formation of a sugar crop restriction and marketing agreement, the possibility of reduction in Cuban duty and finally the overthrow of Mochado Government in Cuba.

Though the world sugar industry of 1933–34 shows a large excess of production over consumption figures in contrast to the previous year, the outlook of Indian sugar industry is definitely better to-day, inasmuch as fear of over-production is lessening. The excise duty has put a wholesome check on excessive expansion of factories and, at the same time, the country has shown signs of increasing sugar consumption.

G. Gundu Rao.

* Review by R. C. Srivastava, Supplement to the *Indian Trade Journal*, Aug 15, 1935.

Science Notes.

Improvising a Paraffin Bath.—Mr. Beni Charan Mahendra, St. John's College, Agra, writes under date 24th August, 1935 :—"Last year, as I did not have sufficient money to buy a paraffin bath for my room, I made one for myself according to a suggestion of McClung.[1] The apparatus did not cost me more than five rupees, and besides being simple, it works as efficiently as an elaborate water-bath with a thermo-regulator can. I pass on the suggestion in the hope that somebody in a situation similar to mine may find it useful.

All that is required is a 100–150 watt gas-filled, electric bulb, a small glass beaker and a clamp-stand. The apparatus is set up as shown in the figure, the beaker is filled up with the paraffin

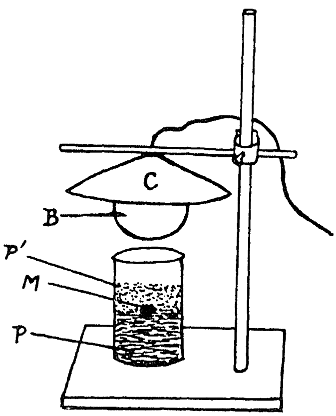

Fig. 1.

The Improvised Bath.

B, electric bulb ; C, Shade for the bulb ; P, Solid paraffin; P′, Molten paraffin ; M, Object to be infiltrated.

of desired melting-point, and the bulb is lighted. The heat given out by the bulb melts the upper layers of paraffin, while the lower layers remain solid. According to the principle of latent heat, the temperature of the paraffin cannot rise above its melting-point as long as there is some solid paraffin left over. The height of the bulb can be adjusted with this end in view, and there is absolutely no necessity of any thermo-regulating device. The object to be imbedded can be transferred to this bath as soon as the upper paraffin has melted. To keep off dust from getting into the paraffin, a sufficiently large wooden-case can be modified to accommodate the whole apparatus inside.

Another cheap method of building a paraffin bath for oneself, which I have not tried, is given by Ballantyne.[2]

[1] McClung, C. E., *Handbook of Microscopical Technique.* (Paul B. Hœber, Inc., 1929, 13.)

[2] Ballantyne, F. M., *An Introduction to the Technique of Section-Cutting* (E. & S. Livingstone, Edinburgh, 1928, pp. 23—25.)

* * *

Recent Archæological Discoveries in S. India.—The discovery of (1) *an inscribed pot from Guntur District,* by Prof. K. A. Nilakanta Sastri, (2) *a Chola Image of Manikkavachaka and some other Images found associated with it,* by Mr. T. N. Ramachandran, and (3) *Prehistoric pottery from the Cuddapah District, including a sarcophagus in the form of a ram,* by Mr. M. D. Raghavan, are among the important announcements made at a recent meeting of the Archæological Society of South India. The pot described by Prof. Nilakanta Sastri bore an inscription in Brahmi characters of the end of the second or the beginning of the third century A.D. and probably recorded that the contained ashes were those of Aryadeva, a man known to have been a pupil of Nagarjuna. The image of *Manikkavachaka,* discovered by Mr. T. N. Ramachandran, was found buried near Madukkur in the Pattukottai Taluk of Tanjore, and bore an inscription in the hand in characters of the period of later Cholas. Mr. M. D. Raghavan's discovery refers to pottery found at Markapuram in the Badval Taluk of Cuddapah District, at a depth of six feet with a unique *sarcophagus.* The sarcophagus possessed a clearly modelled head of a ram the curved horns being emphasised but the ears and tail omitted. It contained a fractional human interment, evidently a secondary burial. The bones were much decayed. The worn state of the molars and the condition of the skull sutures show them to have come from an adult person. It is hoped that this find is only the beginning of a series of similar ones, ultimately leading to the establishment of a much-needed pottery time-scale for South India.

* * *

Some Chemists of Yesterday—formed the subject of the inaugural address to the Chemical Society, University of Mysore, delivered by Dr. Gilbert J. Fowler, D.Sc., F.I.C., on Saturday, the 31st August at Central College, Bangalore. The address was largely autobiographical and contained glimpses of the inspiring work and character of the giants of chemistry, Professors Roscoe, Schorlemmer, Victor Meyer, Gatterman, Dixon, Perkin and others. "The chemist who had learnt his science during the last decade or so, would seem to belong to quite a different school from that of the preceding fifty years." "Modern Chemistry is concerned with the intimate nature of atoms and molecules and their individual reactions, while in the days before isotopes we dealt with mass reactions and were concerned mainly with mass phenomena."

Referring to the teaching of chemistry in India, the lecturer often felt that Indian students suffer under a disability in that much of their training is of necessity at second hand. "Nothing at second hand, *e.g.,* could equal the impressiveness of a lecture by Roscoe on Vanadium, when he described the researches which had enabled him to place this element in its proper place in the periodic table and showed samples of the numerous compounds isolated in the course of the research. In this way it was learnt how new knowledge was actually made and the whole subject was removed from the text-book atmosphere." The number of those who have made real "Path-breaking" research is

increasing in India so that the Indian student has not necessarily to go to Europe for Education. Dr. Fowler concluded the address with a quotation from a recent discourse of Professor Bone, himself a student and colleague of Dixon, as embodying an ideal which may be kept in mind by the students of present day.

"It was a rigorous school of research to which we were admitted, and its discipline was such as only strong minds could stand. As I have already said elsewhere, Dixon's singularly clear and penetrative mind referred everything to the final test of a well-ordered experiment critically carried out without hurry or bias and with the results checked at every point. He impressed upon all the paramount importance of accuracy and truth, together with the highest standard of experimental proof step by step, by a process of exclusion, until it had been narrowed down to a single issue, which finally had to be tested in every possible way. We were taught also to criticise our results, to eschew all rash speculation, and to limit ourselves to such explanations as were proven or provable. Our theories were to be regarded merely as working hypotheses, no more than serviceable tools for accomplishing further advances, and as such always to be subordinated to facts and discarded when outworn."

* * *

Travancore Rubber Factory.—With a view to utilising the raw materials produced in the State, a rubber factory, equipped with modern tubing machines, hydraulic presses, braiding and hose making machines, vulcanisers, spreading machines, etc., has been started at Trivandrum. Messrs. Hermann Berstorff supplied the major portion of the plant and the detailed plan and estimate were prepared by Mr. John Helen, the State Rubber Expert and Engineer, who was formerly Rubber Expert to the Lakshmi Rubber Works, Karachi. The Rubber Factory is the first of its kind in India and is a pioneer enterprise started by the State. Travancore is the largest rubber producing tract in India including the Native States, with an area of 95,800 acres, under rubber, and accounts for more than 75 per cent. of the rubber of very good quality in South India. It has large deposits of very fine China clay, an essential ingredient for the manufacture of rubber goods and plenty of educated and skilled labour is also available.

* * *

The 31st Half-Yearly Meeting of the Indian Central Cotton Committee.—The 31st Meeting of the Indian Central Cotton Committee commenced its session on the 19th of August in Bombay under the Presidentship of Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman of the Imperial Council of Agricultural Research. In response to an invitation, His Excellency the Governor of Bombay was present. Among others present were the Hon'ble Khan Bahadur D. B. Cooper and the Hon'ble Diwan Bahadur S. T. Kambli.

In pursuance of the policy of encouraging long staple cotton in all tracts in India, suitable for it, the proposals of the Chief Agricultural Officer in Sind for the establishment of a compact block of long staple cotton of 300,000 acres in the Barrage areas of Sind by licensing of gins and presses, use of special marks in the licensed factories, seed supply organisation and organised marketing, had received the approval of the Committee at its August 1934 meeting. The Committee after a long discussion adopted a resolution urging the Local Government to translate their recommendations into action without delay and suggesting that the compact area be reserved for the growth (from specially selected government seed) of long staple cotton only, such as 289-F and N.T. and also that the Cotton Transport Act be introduced to prevent the importation of *kapas* from outside areas.

The first annual report of the Lancashire Indian Cotton Committee was considered by this Committee and it expressed its high appreciation of the efforts made by the Lancashire Committee to extend the use of cotton of Indian growth in Lancashire as described therein. The Indian Central Cotton Committee assures the Lancashire Committee of its desire to co-operate to the fullest extent possible in all matters affecting the interests of both bodies.

The Committee noted with satisfaction the Bombay Government's response to its representations for the elimination, by legislative action, of Goghari cotton in the Surat area, the spread of which in recent years has been a serious danger to 1027 A.L.F. The Local Government propose to introduce at an early session of the Council, a Cotton Control Bill on the lines of Madras Cotton Control Act, to prohibit the cultivation of Goghari cotton, its mixture with any other kind, its possession or its use for trading purposes.

The report of the Technological Research Sub-Committee was approved. It showed that a total number of 431 samples were received for tests during the period under review as against 311 during the corresponding period last year. The Committee recorded its appreciation of the valuable work of the Director of the Technological Laboratory, Matunga, whose informative brochure dealing with the work of the Laboratory for the last 11 years was considered and approved. This brochure will shortly be available to the general public.

The progress reports of 30 agricultural research schemes and 15 seed distribution schemes, all of them financed by the Indian Central Cotton Committee, were considered by the Committee and approved. The Jayawant and Gadag No. 1 Distribution and Extension Scheme was sanctioned for 5 years at an estimated expenditure of Rs. 2,66,772. A scheme for the introduction and extension of B.D. 8 cotton which is wilt resistant, in Broach District, was sanctioned for a period of 3 years at a total cost of Rs. 10,160. The Committee approved of the idea of calling a conference of scientific workers on cotton to be held in Bombay soon after the 1936 monsoon meeting of the Committee.

The Central Provinces Government doubted advisability of prohibiting the cultivation of Garrow Hill cotton which had detrimentally affected better types in the Central Provinces and Berar. They thought that the spread of such inferior cotton could be discouraged by penalising its mixing with cotton of superior varieties and decided to undertake legislative measures to penalise the sale of mixed cotton as pure. The Committee decided to request the Central Provinces Government to reconsider the question of prohibiting the growing of Garrow Hill cotton,

as in its opinion the action which the Local Government proposes to take will not prevent the spread of this inferior cotton. The known presence of even small areas of an inferior cotton tends to lower prices in the markets where this cotton is sold and the growers of better quality cotton also suffer.

* * *

The Association of Economic Biologists, Coimbatore.—The Association of Economic Biologists which was founded five years ago, fulfils the supremely important function of bringing together the various specialists of the Coimbatore Agricultural Research Station for (1) taking stock of progress achieved in the different branches of Agricultural Science, and (2) discussions of research problems engaging the attention of the scientific officers of the station. Short notices of the activities of the Association have appeared in the columns of *Current Science* from time to time. The Proceedings of the Association issued annually reflects the activities of the Association. A brochure has recently been issued by the Association covering the period 1934–35. It comprises of six original papers and a number of highly informative lectures constituting an impressive record of the work of the Association.

H. B. S.

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Correlation between Laboratory Tests and Observed Temperatures in Large Dams.—His Majesty's Stationery Office (*Building Research Technical Paper No.* 18. Price 9*d*. net. Post Free 10*d*.)—A knowledge of the temperatures likely to be attained in large masses of concrete is of the greatest importance. The present paper shows, by comparing records made in three large dams now under construction with time-temperature curves obtained in the laboratory, that these temperatures may be predicted from data given by the adiabatic method of curing concrete. The method was described in Technical Paper No. 15. (Price 1*s*. 3*d*. Post Free 1*s*. 5*d*.)

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The Effect of Lighting on Efficiency Rough Work (Tile-Pressing).—His Majesty's Stationery Office (Price 4*d*. Post Free 5*d*).—The report describes experiments undertaken to find out the effect of increasing the illumination in the case of a perfectly simple operation (tile-pressing) for which good lighting was not previously considered necessary. The results show clearly the advantage to be gained by maintaining a reasonably good level of illumination.

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Van Nostrand's Chemical Annual.—Our attention has been drawn to the omission of the name of the Publishers in the bibliographical details relevant to the review of this highly useful handbook, containing useful data for analytical manufacturing and investigating chemists, chemical engineers and students, published in the July number of *Current Science* (Vol. IV, No. 1, p. 68). Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2, are the publishers of this important publication and they also act as agents for the book in the British Empire. The omission is regretted.

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We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 50, Nos. 8–12, and Index to Vol. 49.

"Journal of Agriculture and Live-Stock in India," Index to Vol. III.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4314–4317.

"Indian Journal of Agricultural Science," Vol. 5, Pts. II and III.

"Contributions from Boyce Thomson Institute," Vol. 7, No. 2, April—June 1935.

"Biochemical Journal," Vol. 29, No. 7, July 1935.

"The Journal of the Indian Botanical Society," Vol. 14, No. 2, June 1935.

"The Journal of the Institute of Brewing," Vol. XLI (Vol. XXXII, New Series), No. 8, August 1935.

"Canadian Journal of Research," Vol. 13, No. 1, July 1935, Sections A, B and C, and Index to Vol. XII, Jan.—June 1935.

"Chemical Age," Vol. 33, Nos. 839–842.

"Ceylon Journal of Science," Section B, Zoology and Geology, *Spolia Zeylanica*, Vol. 19, Part 2.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 8.

"Indian Forester," Vol. LXI, No. 9, September 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 22 and 23/24.

"Marriage Hygiene," Vol. II, No. 1, August 1935.

Punjab Irrigation Research Institute, Research Publication No. 8, Vol. II, Nov. 1934: "Protection below Khanki Weir," by J. P. Gunn.

Punjab Irrigation Research Institute, Research Publication No. 9, Vol. II, January 1935: "Influence of an Upstream sheet pile on the Uplift Pressure on a Floor," by N. K. Bose.

University of California Publications in Agricultural Science, Vol. 6, No. 10: "The Chromosomes and Relationship of *Crepis Syriaca* (Borum)," by Donald Ross Cameron.

University of California Publications in Agricultural Science, Vol. 6, No. 11: "Chromosomes and Phylogeny in Crepis," by Ernest B. Babcock and Donald R. Cameron.

Government of India Publication, March 1935: "Monthly Statistics of the Production of Certain Selected Industries of India."

"Rothamsted Experimental Station, Report for 1934."

"The Geological, Mining and Metallurgical Society of India, 11th Annual Report for the Session 1934–1935."

Imperial Council of Agricultural Research, Scientific Monograph No. 5, "The Bombay Grasses," by E. Blatter and C. McCann: Illustrated by R. K. Bhide.

Imperial Council of Agricultural Research, Scientific Monograph No. 6, "Helminth Parasites of the Domesticated Animals in India," by G. D. Bhalerao.

"Report of the Zoological Survey of India for the years 1932 to 1935."

"Annual Report of the Imperial Council of Agricultural Research for the year 1933–34."

"Nature," Vol. 136, Nos. 3430–3433.

"The Journal of the Bombay Natural History," Vol. 38, No. 1.

"The Journal of Chemical Physics," Vol. 3, No. 8, August 1935.

Academies and Societies.

National Institute of Sciences of India:

August 23rd, 1935.—SYMPOSIUM: *Discussion on Problems of the Ionosphere.* S. K. MITRA: The Ionosphere constitutes the vast stretches of ionised regions in the upper atmosphere, the lower boundary being at a height of about 90 kms. The upper boundary extends beyond 400-500 kms. It is explored experimentally by the study of the reflection of wireless waves. Such studies have given information about the height, ionisation density, density gradient, structure, intensity of the magnetic field, collisional frequency between electrons and neutral atoms or molecules at ionospheric height, polarisation of the down-coming waves and temperature of the ionosphere. The main ionising agency is the ultra-violet rays of the sun. S. K. BANERJI: *Thunderstorms and Magnetic Storms in Relation to Ionosphere.*—The influence of the earth's magnetic field is such as to make the ionosphere an aelotropic medium and owing to the difference in the group velocities of the two components, a single wireless pulse may be split into a doublet. Magnetic storms are connected with abnormal ionisation and this is probably associated with high speed charged particles from the sun. There appears to be extraordinary variability in ionospheric weather and it would be interesting to correlate them with magnetic variability. The sudden appearance of bursts of abnormal ionisation is associated with thunderstorms. There is a close relationship between thunderstorm activity and sun spots. G. R. TOSHNIWAL: *Ionosphere at Allahabad.*—By the method of Breit and Tuve, it has been found that normally a 4-kilocycle wave is reflected from the F-layer at a height of about 250 km. The ionisation decreases gradually after sunset and the equivalent height from which the reflected wave emanates gradually increases and about 2 hours after sunset the 4-kilocycle wave is not reflected from the ionosphere. At the time of the lunar eclipse on January 19th, 1935, using a 75-metre wavelength it was found that the equivalent height of the F-layer was almost constant up to 18 hours 20 minutes, after which it rapidly rose to 400 km. and then began to fall and was minimum when about three-quarters of the moon was dark. After totality the equivalent height again began to increase and within 20 minutes no echo could be seen due to electron limitation. P. SYAM: *The D-Layer.*—The detection of echoes from a virtual height of about 55 km. gives direct proof to the existence of a low layer at this height during the day time. The echoes are of infrequent occurrence. Other evidences also exist in support of the presence of the D-layer. It has been found that during the day time there is a frequency band which is reflected from the E-region. The upper limit of the band is due to the penetration of the E-layer, and may be termed the "penetration limit". The lower limit which may be termed the "Absolute limit" is due to the absorption by the D-layer on account of large collisional frequency present therein.

Indian Academy of Sciences:

August 1935. SECTION A.—P. S. SREENIVASAN: *Raman Spectra of Isoprene, Dipentene, and Ocimene.*—Specially chemically pure substances have been prepared and studied. T. S. SUBBARAYA: *Analysis of the Spectrum of Trebly Ionised Zinc: Zn IV.* C. S. VENKATESWARAN: *The Raman Spectra of Iodic Acid and the Alkaline Iodates as Solids and Solutions.*—The dissociation of iodic acid is incomplete even at concentrations of 0·5 N. It is suggested that the acid is polymerised in the solutions to an appreciable extent, the polymerisation decreasing with dilution. The IO_3 ion exhibits all the four vibration frequencies and two parallel vibrations exhibit splitting, indicating that the IO_3 radical is pyramidal in structure with the I atom close to the plane of the O atoms. A number of low frequency oscillations have been observed and an explanation suggested. R. ANANTHAKRISHNAN: *On the Convergence Error in Depolarisation Measurements.*—It is shown that the observed values of the depolarisation would be higher than the genuine values by a correction factor which involves the square of the angle of convergence. The necessity for the perfection of the optical parts used in depolarisation work is emphasised. N. S. NAGENDRA NATH: *The Dynamical Theory of the Diamond Lattice.—Part III. The Diamond-Graphite Transformation.* The temperature at which diamond becomes unstable and transforms to graphite is calculated and is shown to be in good agreement with the experimental determinations. R. ANANTHAKRISHNAN: *Redetermination of the Depolarisation of Light Scattering in Gases and Vapours.*—The corrected results with improved technique yield in general much smaller values than hitherto reported: the results are in greater agreement with theory. P. S. VARADACHARI: *Influence of the Formation of Hydrates on the Diamagnetism of Chemical Compounds.*—Results are reported on the aqueous solutions of sulphuric acid, acetic acid and sodium sulphate, over the complete range of concentrations. S. CHOWLA: *Irrational Indefinite Quadratic Forms.* M. SURYANARAYANA: *Positive Determinants of Binary Quadratic Forms whose Class-number is 2.* I. CHOWLA: *On Sums of Powers.* G. S. DIWAN AND V. V. NARLIKAR: *A Practical Financial Transaction.*—It is proved straight from the definition that a *practical* transaction admits of only one rate of interest. The multiplicity of the rate of interest for a transaction shown by Misra is only mathematically possible. G. R. GOGTE: *Chemistry of β-Aryl Glutaconic Acids. Part II. Condensations with Phenolic Ethers.* H. GUPTA: *On the P-Potency of G* $(p^{\alpha}-1, r)$. B. VENKATESACHAR AND L. SIBAIYA: *Iridium Isotopes and their Nuclear Spins.*—The hyperfine structure patterns of some of the significant arc lines of iridium have been studied. Two isotopes of mass 191 and 193, abundance ratio 1:2, and nuclear spins $\frac{1}{2}\frac{h}{2\pi}$ and $^{3}/_{2}\,\frac{h}{2\pi}$ have been distinguished. The estimated atomic weight 192·4 shows that the accepted chemical atomic weight 193·1 is too high.

SECTION B.—H. CHAUDHURI AND P. L. KOCHHAR: *Indian Water-Moulds—I.*—The cultural characteristics of 20 species of water-moulds, some of which have not been noted before in India, have been described and fully illustrated. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric Mill in Decapoda VI.*

The Structure of the Gastric Mill in Natantous Macrura—Penœidea *and* Stenopidea: Conclusion. —The various types of gastric mills found in the Decapoda can be arranged in a series ranging from simple to complex. Reptantous habit is associated with the possession of a complex gastric mill and simple mandibles and the Natantous habit with the possession of a reduced gastric mill and complex mandibles. H. S. RAO: *The Structure and Life-History of* Azolla pinnata *R. Brown with Remarks on the Fossil History of the Hydropteridex.*—Fertilisation takes place in September or October. The resulting fresh plants mature in spring. By about April the sporocarps ripen and are shed. The spores rest during summer. The megasporocarp with the attached massulæ floats up before fertilisation. A. SREENIVASAN: *Investigations on the Rôle of Silicon in Plant Nutrition. Part II. Adsorption of Silica in Soluble Forms by Colloidal Oxides of Iron and Aluminium.* The possible significance of silicate adsorption in relation to phosphorus resorption in soils is indicated. Y. V. NARAYANAYYA AND V. SUBRAHMANYAN: *Estimation of Nitrogen by Fumeless Digestion. Part I.*—The material is first boiled with manganous sulphate and sulphuric acid (2 : 1) for 30 minutes. Potassium dichromate is next added and the boiling continued for a further period of 30 minutes after which the digest is reduced with zinc and distilled with excess of alkali, as in the Kjeldahl procedure.

The Academy of Sciences, U.P.:

An ordinary monthly meeting of the Academy was held at Allahabad on the 27th July, with Prof. N. R. Dhar, President of the Academy, in the Chair. The following papers were read and discussed:—

(1) "The Chemical Examination of the Fruits of *Lagenaria vulgaris* Seringe (bitter variety)". Part I. The Constituents of the Oil from the Seeds," by Radha Raman Agarwal and Shikhibhushan Dutt, Chemistry Department, Allahabad University, Allahabad. (2) "Colour and Constitution of Dyestuffs derived from Flourenone," by Mohit Kumar Mukerjee and Shikhibhushan Dutt, Chemistry Department, Allahabad University, Allahabad. (3) "New Trematodes of the Family *Lecithodendriidæ* Odhner, 1911, with a discussion on the classification of the family," by H.R. Mehra, Zoology Department, Allahabad University, Allahabad. (4) "Preliminary Account of New Trematodes with Ani." by S. C. Verma, Zoology Department, Allahabad University Allahabad. (5) "A Note on the Colouring Matter of the Flowers of *Lantana camera* Linn.", by Jagraj Behari Lal, Chemistry Department, Allahabad University, Allahabad.

At the meeting of the Academy held on the 16th August 1935, the President announced that the Allahabad University had renewed the grant of Rs. 500. The following papers were read and discussed:—

(1) "Further Experiments on the Fixation of Atmospheric Nitrogen in the Soil and the Utilisation of Molasses as a Fertilizer," by Prof. N. R. Dhar and Mr. S. K. Mukerjee.—The experiments of Prof. Dhar lead to the conclusion that the oxidation of the energy-rich carbohydrates present in the molasses causes the fixation of atmospheric nitrogen leading to an increase of ammonium salts and nitrates in the soil. (2) "The Nitrogen Atom and the Molecule," by L. S. Mathur. (3) "Contributions to the Digenetic Trematodes of the *Microcheroptera* of Northern India, Part III. —New Distomes the genus *Mesodendrium faust* (1919)," by B. P. Pande. (4) "On Evidences for a Lag Effect in Zeuner's Data on Saturated Water Vapour in Landolt and Bornetein's Table," by Prof. Satyendra Ray. (5) "On Evidences of Tidal Waves in an Insulated Molten Interior as obtained in some Recent Severe Earthquakes," by Prof. Satyendra Ray.

A Symposium on the 'Theory of Relativity' was held on the 17th August. Sir Shah Muhammad Sulaiman opened the discussion. In the course of his speech, he answered the criticisms of Mr. D. R. Hamilton and Mr. Satyendra Ray. He predicted that the deflection of light from a star passing the sun would be between 2″.32 and 2″.45 as against Einstein's value of 1″.75. The spectral shift of light from the limb of the sun according to his theory will be 0.00676, a value which was nearly the same as that obtained by Evershed in 1918. Einstein's theory gives the value as 0.0084. Professors A. C. Banerji, Satyendra Ray and M. N. Saha were the other speakers. Dr. Gorakh Prasad and Mr. Rama Nivas Rai also took part in the discussion.

The Indian Chemical Society:

June 1935. J. C. GHOSH AND P. C. RAKSHIT: *Oxidation of Sugars by Air in Presence of Ceric Hydroxide Sol and Cerous Hydroxide Gel.* M. R. ASWATHANARAYANA RAO: *Effect of Temperature on Selective Adsorption by Silica Gel from Binary Mixtures.* SOBHANLAL BANERJEE AND H. K. SEN: *Effect of Ultra-Violet Light on Enzymatic Reactions. Part I. Diastase.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *Chemical Examination of* Cuscuta Reflexa, *Roxb. Part I.—The Constituents.* JAGRAJ BEHARI LAL AND SIKHIBHUSHAN DUTT: *Metallic Uranium in Organic Synthesis. Part I.* MOHAN LAL BEHARI, KARTAR SINGH NARANG AND JNANENDRA NATH RAY: *Vasicine.* B. L. MANJUNATH AND S. SIDDAPPA: *On the Supposed Occurrence of Acids with Uneven Number of Carbon Atoms in Vegetable Oils and Fats. Part I.*—Daturic Acids from the Seeds of *Datura Stramonium*, Linn. SUSIL KUMAR RAY: *Parachor and Chemical Constitution. Part III.—The Structure of Urea and Thiourea.* NRIPENDRANATH CHATTERJEE: *Studies in Diphenyl Series. Part I.—Synthesis of Unsymmetrical Derivatives of Diphenyl.* NRIPENDRANATH CHATTERJEE: *Studies in Diphenyl Series. Part II.—A New Method of the Synthesis of 9-Hydroxyphenanthrene.*

July 1935. B. B. DEY AND (MISS) P. LAKSHMI KANTAM: *Studies in the Cotarnine Series. Part II.—The Reaction of the Aldehyde Group in Cotarnine and Benzoyl Cotarnines.* B. B. DEY AND (MISS) P. LAKSHMI KANTAM: *Studies in the Cotarnine Series. Part III.—Isomeric bis-Cotarninoacetones.* N.R. DHAR AND S.K. MUKHERJI: *Influence of Temperature on the Carbon-Nitrogen Ratio of Soils.* J. K. CHOWDHURY, A. C. CHAKRABARTY AND A. MAZUMDAR: *Polymerisation of some Unsaturated Fatty Acids.* U. D. BUDHLAKOTI AND K. C. MUKHERJI: *A Note on the Thiocyanogen Value of Indian Butter Fat (Ghee).* SIKHIBHUSHAN DUTT: *Putrefactive Decomposition of Bengal Silk Cocoon.* KUMUD BEHARI PATHAK:

A Note on the Condensation of ω-Bromoacetophenone with 1-o-Aminophenyl-3-phenylthiocarbamide. D. N. BEDEKER, R. P. KAUSHAL AND S. S. DESHAPANDE: *Reactivity of Carbonyl Group in γ-Pyrones and γ-Pyridones.* PULIN BEHARI SARKAR: *The Chemistry of Jute-lignin. Part VII.—The Behaviour of Organic Compounds* towards ClO_2 and its Significance on the Constitution of Lignin. P. R. KRISHNASWAMY, B. L. MANJUNATH AND S. VENKATA RAO: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn. Part I.* N. G. GAJENDRAGAD AND S. K. K. JATKAR: *Equilibrium between n-Propyl Alcohol, Propyl Ether and Water at* 190°. U. S. KRISHNA RAO, B. L. MANJUNATH AND K. N. MENON: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn. Part II.* BALBHADRA PRASAD: *Viscosity of Dilute Solutions of Non-electrolytes.*

Indian Botanical Society:

June 1935.—H. CHAUDHURI AND PUSHKAR NATH: *Studies in the Diseases of Apples in Northern India—I. A New Leaf-Spot Disease of Apples caused by* Oothecium indicum *n.sp.* R. E. COOPER AND S. A. PASHA: *The Osmotic and Suction Pressures of some species of the Mangrove Vegetation.* PUSHKAR NATH: *Studies in the Diseases of Apples in Northern India—II. A short note on Apple Scab due to* Fusicladium dendriticum *Fuckel.* K. RANGASWAMI: *On the Cytology of* Pennisetum typhoideum *Rich.* PARAM NATH BHADURI: *Studies on the Female Gametophyte in Solonaceæ.* T. S. RAGHAVAN: *Observations on the Somatic Chromosomes of* Urginia indica *Kunth.* MISS E. BAPTISTA: *Respiration of the Roots and Leaves of the Rice Plant* (Oryza sativa *L.*). N. K. TIWARY: *Observations on the Artificial Germination of* Cyathodium *Spores.* B. S. KADAM: *Inheritance of Root Colour in Rice.* H. R. BHARGAVA: *A Cheap Device for Using Safety Razor Blades for Microtome Sections.*

Reviews.

INTRODUCTION TO PHYSICAL SCIENCE. By Carl W. Miller, Ph.D., Associate Professor of Physics in Brown University, New York. (John Wiley & Sons, Inc.). Price 5*s*.

In this second edition of the book the latest developments in Physics such as Artificial Radioactivity find a place and are treated in a manner conforming to the object which the author has in view in writing it, *viz.*, to provide a one-year general course to the student who may not specialise in the subject afterwards. The method of treatment is clear and attractive avoiding all mathematics unnecessary to an elementary treatment. In these days the revolutionary advances in Physics have not only greatly influenced civilised life but have given a distinct new orientation to philosophic thinking with the result that no one claiming to be a cultured member of society can afford to be ignorant of the fundamental teachings of modern Physics. Here is a book which we can confidently recommend to one who is anxious to get a correct idea of what modern Physics means. Relativity, Quantum Theory, Wave Mechanics, Electron Diffraction and Nuclear Physics are all dealt with in a manner acceptable to the elementary student of the subject. The examples at the end of each chapter are appropriately chosen to illustrate the main points treated in the corresponding chapters. To the first year students in Indian Universities the book under review will be invaluable.

B. V.

PHYSICS FOR COLLEGE STUDENTS. By A. A. Knowlton, Ph.D. (McGraw Hill Book Company Inc., 1935.) 2nd Edition, pp. 623. Price 21*s*.

This book is written by a professor of physics in an American College, and is meant for students in American Colleges who take up an elective course of study in Physics for their graduate course. These students do not propose to continue their study of Physics beyond their one year's prescribed course, and to meet their requirements the author has written the above text-book. From it a knowledge of the essential parts of Physics can be obtained by a student in the course of one session's study of four hours a week. It is written more from a humanistic rather than a purely technical standpoint. It is shown how during the ages man has gradually acquired a mastery over his physical environment and thus been able to harness the forces of nature for his own use. During the course of this evolution he has gradually developed a mode of interpreting the natural phenomena which is incorporated in what is known as scientific explanation. In accordance with this standpoint of the author, the methods of measuring work and the different kinds of energy, mechanical, heat and electrical, are introduced early in the book. The whole of Physics is surveyed in about fifty short chapters, and the author has incorporated a large amount of modern Physics in it. The treatment is on the whole descriptive with a little of essential mathematics thrown

in. The book does not follow the usual sub-divisions of the subject into Mechanics, Sound, Light, etc., and in arranging the subject-matter the author had partly the pedagogical method of 'soaking in process' in view, *viz.*, so much and only so much of a subject is introduced as is required at that point. As its next introduction, something further is added to the material which has become part of the mental background of the student through use.

As will be seen the book is written from a novel standpoint and contains many valuable features. So far as the reviewer can judge, the book will not fit in with any of the syllabuses on Physics prescribed by the different University examinations of this country, but it can be recommended to all students preparing for the pass B.Sc. examinations, for supplementary reading.

D. M. BOSE.

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LEHRBUCH DER THEORETISCHEN PHYSIK. By G. Joos. (Akademische Verlags Gesselschaft, Leipzig.) 2nd Edition. Price RM. 24.

The attempt to present the whole of mathematical physics in a single volume is a bold venture and necessitates a careful selection of the subject-matter and sometimes a short-cut through the mathematical foundation. The particular value of this book in the opinion of the present writer lies in the fact that it shows the edifice of Physics unburdened by experimental details; yet nowhere does the mathematical deduction make the reader forget the physical conceptions. German scientific literature has always excelled in text-books on mathematical physics and it is extremely satisfactory that this series of valuable textbooks has been supplemented by this concise volume. The new English edition can be strongly recommended to the post-graduate students and teachers of this country. After a first introductory chapter, in which the mathematical tools of the Physicist are treated, the author deals with mechanics and hydrodynamics, and relativity theory in the second book. The different chapters of the third book deal with the classical theories of electrodynamics and optics, and the fourth with the electronic theory of both. Again thermodynamics which follows, is treated first in the classical way and then as kinetic theory. The seventh and last book deals with the structure of atoms and molecules and the theory of spectra, and here again a clear division between quantum theory and quantum mechanics is introduced. Wavemechanics, the wavemechanical theory of valency and dispersion and the structure of the nucleus are about the last questions which are treated.

R. SAMUEL.

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SOLID GEOMETRY. By L. Lines, M.A., B.SC. (Messrs. Macmillan & Co., Ltd., London, 1935). Pp. 292. Price 6*s*. net.

The purpose of the book appears to be partly to provide a treatise on Solid Geometry (Euclid XI), as is usually taught in our Intermediate courses, but with an elaborate collection of examples; and partly to provide a preface to the study of crystallography, and arrangement of atoms in crystals. The first six chapters deal with the theorems on Solid Geometry as are usually taught in our intermediate classes. These are followed by two chapters on Mensuration and one on Centroids. Then follow chapters on Rabatment, Polyhedra, Semi-Regular and Star-Polyhedra, Space-Lattices, Sphere-Packs, Patterns and Crystals.

The book deserves attention from every teacher of the subject on account of its wide range of problems, and variety of subjects. But we cannot help remarking that there is too much of drilling of pure geometrical methods for proving results many of which could be easier proved and better appreciated by the methods of analytical geometry and the calculus. No doubt, the use of purely geometrical methods to a certain extent is highly desirable and wholesome in these days when there may be a tendency to use the analytical machines too often; but if the methods of pure geometry are carried too far, they can only savour of pedantry on the author's part, and constitute what is often called "murdering of mathematics".

C. N. S.

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STRUCTURE NUCLÉAIRE: par G. Guében. (No. 247 of the Actualités Scientifiques et Industrielles). (Hermann et Cie, Paris, 1935.) Pp. 36. Price 10 *fr*.

The structure of the nucleus is a problem which is being actively attacked by a number of methods but we cannot say that there is any definitely established solution yet. The view that the nucleus consists of protons and electrons, the latter having combined as far as possible into α-particles, has been given up and we now think of the

nucleus as consisting of protons and neutrons. Although there are strong grounds for believing that pairs of protons and neutrons are combined as far as possible into α-particles, there are many authorities who consider the protons and neutrons to exist without such combination. Admitting, however, that there are the maximum possible α-particles formed, one proton will be left over when the atomic number is odd. Walke has tried to maintain the view that this extra proton is always combined with a neutron forming a deuton. However, the statement that any particular nuclear property is present when there is a deuton is simply equivalent to admitting the existence of the property when there is an odd proton, *i.e.*, when the atomic number is odd. The brochure under review develops Walke's proposition in detail and tries to answer some objections to that view. There is one nuclear property, however, which, in spite of its importance, has not been considered in the present book—we mean the magnetic moment of the nucleus. Experiment having shown that the deuton has a magnetic moment of 0·75 nuclear magneton, the large magnetic moments of Li, Al, etc., for example, cannot be explained if the odd proton is supposed to be combined with a neutron to form a deuton. The time is not ripe for taking any particular theory of the nucleus as finally established, but the book will serve to render one aspect familiar to French readers; the danger, however, remains that the reader may mistake the thesis of the book for the accepted view.

T. S. S.

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RAYONS COSMIQUES. par B. Rossi. (No. 248 of the Actualités Scientifiques et Industrielles.) (Hermann et Cie, Paris, 1935.) Pp. 48. Price 12 *fr.*

Our conception of the nature of cosmic rays has undergone a transformation in recent years mainly as the result of the work of J. Clay, B. Rossi and A. H. Compton. While the earlier view was that cosmic rays were very short γ-rays, the current opinion is that they almost entirely consist of particles. Compton distinguishes three groups A, B and C according to their penetrating power and shows reasons to believe that they consist of α-particles, electrons both positive and negative and protons respectively. The change of view was the result of the discovery of the latitude effect and its variation with height. The experimental facts and their significance are presented in a masterly way, the account being clear and authoritative. The language is also readable, the results being expressed definitely but with cautious reserve. Some other up-to-date accounts of cosmic ray research have recently appeared, particularly A. H. Compton's Guthrie Lecture (*Proc. Phys. Soc. London*, 1935, **47**, 747–773). Rossi's monograph can be advantageously studied side by side with Compton's paper, the two supplementing each other to the reader's great advantage. We heartily recommend this monograph to all students of modern problems in Physics and congratulate the publishers on securing such an authoritative presentation of a subject of great interest and importance.

T. S. S.

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TRANSMUTATIONS DES ÉLÉMENTS PAR PARTICULES ACCÉLÉRÉES ARTIFICIELLEM... Par Manuel Valadares. (No. 245 of ... Actualités Scientifiques et Industriel... (Hermann et Cie, Paris, 1935.) Pp. ... Price 10 *fr.*

The present work contains a detailed ... cussion of the transmutations effected ... means of artificially accelerated par... such as protons and deutons. The pio... work of Cockeroft and Walton and Lawrence has led to a vast extension o... knowledge of nuclear reactions and ... book under review gives a clear accou... these developments. The technique of ... ducing the high energy missiles i... described. The important results ob... by α-particle bombardment and by ne... bombardment do not find a place in ... book since α-particles and neutrons a... artificially accelerated. Such a separ... of the results into artificial groups ... because of a name prevents us from h... a synthetic view of the whole phenome... nuclear transformations. Some of the ... culties regarding the masses of the pa... in nuclear encounters discussed in the ... have recently been removed by a deter... tion of the masses of light nuclei fr... study of nuclear transformations by ... and by Oliphant and others and A... confirmation of a number of these ... values. The book, however, when ... along with others of the series such as ... Curie and Joliot on "Artificial Radioact... and J. Perrin's on "The Nuclei of A... will serve as a valuable compendium of ...

results obtained in a most important and fascinating field of research.

T. S. S.

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DYNAMICS OF POPULATION: SOCIAL AND BIOLOGICAL SIGNIFICANCE OF CHANGING BIRTH-RATES IN THE UNITED STATES. By Frank Lorimer and Frederick Osborn. (The Macmillan Company, New York, 1934.) Pp. xiii+461. Price 15*s*.

Students of Social Demography will welcome this valuable addition to the scanty literature on the subject. The authors who have both practical and theoretical knowledge of the problems they are handling come to certain useful and important conclusions of the population trends in the United States. These, we hope, will be of interest not only to the American students but to all who are working on the subject throughout the world. The purpose of the book, as the sub-title implies, is a scientific study of the causes and effects of population changes.

The population of the United States is divided into classes under various headings such as national origin, occupation, social and economic status, etc. As a sequel to these a brief survey of the physical and mental characteristics of these groups is given laying stress on the variations in intellectual and cultural development. A clear line of demarcation is drawn between the rural and urban population pointing out clearly the differences in physical and mental attainments of both. With the data derived from these studies the authors have endeavoured to forecast the relative strength of the various national groups in the population of the next century.

Another important topic perused at length is the difference in reproduction rates among the groups, as the classes having higher birth-rates and greater vitality will predominate in the long run. It is also a painful reality that in areas least able to support a teeming population do we obtain maximum fertility among the groups. As a result of this investigation, the authors deduce that a sorting process is at work, establishing gradients in intellectual capacity and so intelligence ratings are bound to differ for such classes. It is abundantly clear that capacities are inherited and so a slight enhancement in the reproduction rate of these groups that have a higher average capacity for intelligence and a correspondingly slight decrease in the rate of reproduction of the less gifted groups would largely increase the number of individuals of higher capacity and considerably decrease the number of imbeciles. But it is painfully brought home to us that the present population trends are heading to the opposite result.

The other problems discussed are the causes for the observed population trends and the conclusion arrived at is that reproduction rates among the groups occupying high social levels are low. Nevertheless it is clear that economic factors and the particular method of family limitation prevalent among these groups largely determine fertility.

Another conclusion put forward is that no group with high standards of living and a knowledge of the methods of birth control can be looked forward to be self-replacing permanently unless conditions conducive to fertility intervene.

The last and perhaps the most important subject dealt with in the present volume is the possibility of social control and the suggestion that city planning and increasing the economic security of young couples holds out the greatest promise for such control.

It is needless to expatiate on the usefulness of the book to those for whom it is intended and we hope that similar careful and scientific study of the vital problems of population will be undertaken by international co-operation and collaboration.

C. N. R. R.

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TRAVANCORE GOVERNMENT ARCHÆOLOGICAL DEPARTMENT ADMINISTRATION REPORTS FOR THE YEARS 1108 M.E. AND 1109 M.E. (1932–33 AND 1933–34).

The Annual Reports of the Travancore Archæological Department are, unlike the detailed reports of the Government of India, merely brief Administration Reports. They have both the advantages and the disadvantages of brevity and cheapness and perhaps approach more nearly to punctuality than the bulkier and more detailed reports of the Government of India.

Under the head Conservation one would perhaps be justified in expecting a more detailed statement of the arrangements made and the expenditure incurred for the conservation of the ancient monuments in the State. It is difficult to believe that only Rs. 500 were spent in 1108 M.E. for this purpose and that nothing was spent in 1109 M.E. The Archæological Department

may collect the relevant information from the Department of Public Works, and publish it. Whenever any repairs are to be done to any of the ancient monuments of the State the approval and co-operation of the Archæological Department ought to be obtained, and the latter should keep a record of all such work.

The scientific work done by the Department during the years under review appears to be considerable both in quality and quantity. In the year 1108 M.E., 43 new inscriptions were examined, the earliest stone inscription being dated Kollam 301 (1126 A.D.). Brief notices of most of the inscriptions and a tabulated statement about them are given in an appendix. The report for 1109 M.E., however, is silent about inscriptions. It may be suggested that a systematic collection of epigraphical records may be made and the texts of those collected may be published from time to time. The coins studied during the year also need more detailed descriptions and clearer illustrations.

Two valuable items published in the report for 1108 M.E. are an Archæological map of the Travancore State and a table tracing in detail, of the evolution of the Vatteluttu alphabet, both of which would be found highly useful to scholars.

In the report for the year 1109 M.E. the chief piece of work described under 'Conservation' is the copying of the wall paintings found on the Gopura of the Temple at Ettumanur in North Travancore, which is ascribed to a period not later than the 16th Century A.D. The theme is that of Shiva's great dance on the destruction of the Demon Apasmara. A half-tone illustration of the central panel is given, and the painting is described as one of the great triumphs of pictorial art in Travancore.

Another piece of work connected with painting was the identification of the scenes and stories of the mural paintings in the Sri Padmanabhaswami Temple at Trivandrum. " In the vitality of the figures, and in the infinite variety of poses, gestures and emotions throbbing with life, lies the secret of their charm and attractiveness. Supreme examples of a wonderful combination of both ' Rupa ' (beauty of objective realisation) and ' Rasa ' (grace of emotional expression), many of these paintings have a grandeur and sublimity of conception rarely to be found in many other temples of the State."

Other pieces of useful work done during the year are: the trial excavation of some prehistoric burials at Panjapalli-Parambu near Shoranur, the discovery of a small rock-cut temple of the 11th Century A.D. near Marayur, the study of Vedic chanting and the connected hand poses, and the review of an unpublished Sanskrit manuscript on histrionics and dramaturgy, called " Bālarāmabhāratam". The author of the last-named book was Bālarāma Kulaśekhara Vanchi Bhūpāla, a Travancore king. The work is a valuable one and expounds the art of dancing and gesture somewhat on the lines of the *Abhinaya-darpana* of Nandikeśvara.

Both the reports show that Travancore is a highly valuable field for archæological investigation. It may be suggested that a systematic survey of the State may be made on a regular plan and the information about the finds published in greater detail with more illustrations.

Mr. R. V. Poduval, the Superintendent, and the Archæological Department may be congratulated on the great opportunities for study that they have before them and the interesting beginnings they have made in the years under review. Travancore is a storehouse of South Indian culture and it is to be hoped that her enlightened Government will push on the work of conserving her ancient monuments and publishing authentic information about them.

M. H. KRISHNA.

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COLLOID CHEMISTRY. By Arthur W. Thomas. (McGraw Hill Publishing Company, Ltd., 1934.) Pp. viii + 512. Illustrated. Price 24*s*. net.

This volume provides a valuable introductory guide on all phases of colloid chemistry which is treated from the entirely new viewpoint of crystalloidal chemistry, taking into consideration the chemical nature and composition of the colloidal particle. The subject is comprehensively covered by eighteen chapters, each of them being devoted to a discussion of a particular aspect of colloid chemistry. The chapters on colloid optics, dialysis and ultra-filtration and preparation of colloidal solutions, deal with the experimental technique involved in the preparation, purification and study of colloids. The nature and mechanism of dialysing and ultra-filter membranes are discussed in Chapter V which also includes a very informative review of the latest theories on the nature of membrane permeability, and this

important aspect of the subject has been covered in this volume more extensively than in any other book.

A particularly striking feature of this volume is the treatment it has accorded to the two important classes of biocolloids, proteins, and carbohydrates, which will be appreciated by investigators interested in them. A study of these chapters will reveal that the latest developments in this branch, like the researches of Svedberg with his ultra-centrifuge on the molecular or micellar weight of these complex compounds, have been included. There are excellent chapters devoted to a discussion of the nature of micelles, precipitation by electrolytes, electrokinetic phenomena and sorption, aspects of colloid chemistry which will interest not only physical chemists but also others, whose work lies on the borderline between physical chemistry and biology. The fact that information of great technical significance is also to be found in the volume, particularly in chapters on soaps, foams and emulsions, will serve to extend the usefulness of this book into the field of chemical technology. The list of well-chosen and relevant references which will be found at the end of each chapter constitutes a valuable feature of the volume.

M. S.

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INDIVIDUAL HEALTH.—A Technique for the study of individual constitution and its application to Health. By E. Obermer. VOL. I. BIOCHEMICAL TECHNIQUE. By E. Obermer and Molton. (Chapman & Hall, Ltd., 1935.) Pp. xvi+244. Price 15*s*.

The tendency among physicians in the present period of transition from *Pathological* to *Preventive* medicine is to pay attention to the prevention of disease by promoting individual and public health. The physician is concerned with an enquiry into the root-cause of diseases, and he endeavours to maintain the individual in a fit condition, which will enable him to ward off diseases. Obermer proposes a technique of 'adaptational survey' which will enable one to assess the efficiency with which a subject can adapt himself to diet, habit and environment.

The 'adaptational survey' includes a study of heredity and constitution factors, external environmental factors and the reaction of internal to environmental factors. Such a study will give a measure of the functional efficiency and any disorder in the system, strain or lowered resistance can be detected and remedied in the early stages, thus preventing any manifestation of pathological symptoms. The scheme represents the first systematic attempt of individual examination and its success will depend on the co-operation of the members of medical profession and the successful education of the general public on the value of individual health.

The present volume deals with the biochemical technique of the 'adaptational survey' and includes (1) weighing and measuring of food for 24-hour periods, (2) quantitative analysis of normal blood constituents, (3) detailed examination of each urine passed during 24-hour periods, (4) fæcal analysis, and (5) measurement of respiratory metabolism together with the assessment of specific dynamic action of foods. The results of such analyses give a quantitative picture of the dietetic and excretory habits of the subject and permits of an interpretation of endocrine, renal and gastro-intestinal efficiency.

The book is divided into two parts. Part I deals with directions for collection of specimens of ingesta, urine and fæces. Part II deals with the collection and distribution of specimens within the laboratory and also gives a description of a type of laboratory organisation for mass analysis. The methods described in this volume are mainly microphotometric, so that it is possible to carry out a large number of routine analyses with maximum accuracy compatible with minimum quantity of biological material and economy of time. A useful bibliography is appended. This part will prove to be a useful handbook to analysts interested in problems of public health, physiology and pharmacology.

N. C. D.

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THE SCIENTIFIC JOURNAL OF THE ROYAL COLLEGE OF SCIENCE. (Edward Arnold & Co., London.) Vol. V, pp. 137. Price 7*s*. 6*d*. net.

This Journal published as a neatly bound book, contains fourteen papers read during the session 1934–35 before the Imperial College Chemical Society, Natural History Society, Mathematical and Physical Society of the Royal College of Science. The fourteen papers are allotted in the order of seven, four and three among the above institutions and include a variety of interesting and important topics.

The opening discourse in the Chemistry Section is on Selenium dioxide: Professor Riley discusses at length the oxidising properties of the dioxide and its application to synthetical processes. Another noteworthy article is that on the chemistry of Gold. In this lecture recent progress in the chemistry of organo-gold compounds are treated from an advanced standpoint. In a short address Dr. Rawling has set forth some chemical themes pertaining to photographic technique and deals in an admirable manner with the curious properties of optically sensitive materials. Professor Ingold's paper on "Aliphatic Substitution" is primarily devoted to a discussion of the modern conception of valency as applied to organic compounds and the kinetics of organic reactions like hydrolysis of esters and so on. The more important subjects included in the Natural History Section are Timber Research, the Significance of Smell and the Origin of Insects. Under Timber Research, an account of the highly useful work that is carried out at the Forest Products Research Laboratory in Princes Risborough is given with a note on the structure and utility of various kinds of timber. The ingenious study on the significance of smell (some speculations on the phenomenology of olfaction) provides eminently readable matter. A clear distinction is drawn between the related sensse of olfaction and vision and the fact that smell plays a predominant role in the study of memory is stressed. The lecture on the origin of insects is at once a lucid exposition of the theory of segmentation in the Arthropoda and an unbiassed criticism of Tillyard's theory put forward in 1931. In the general trend Mr. Reynolds favours the theory proposed by Lankester in 1904. The importance of the gonopore position has not been forgotten as is usual with the theorists. It remains to be seen whether the views set forth here hold their ground against those of the rivals as this highly controversial subject must needs stimulate others to come forward to dispute.

The first paper in the Mathematical and Physical Section is on "Television" which is a highly illuminating and technical address. The disquisition on "Surface Integrals and Fluxes" is of special significance as Professor Fortesque was personally concerned with the deliberations of the subcommittee of the British Standard Institution. Here difficulties of defining the unities of permeability, susceptibility and other fundamental electro-magnetic quantities are at one stroke removed by defining these in terms of undisturbed space. The short abstract of Professor E. A. Milne's paper on the "Expanding Universe" though concise is highly interesting.

The fifth volume preserves all the merits which have characterised its precursors and is on the whole a very representative collection of excellent documents of readable matter.

C. N. R. R.

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LES CAROTENOIDES DES ANIMAUX PAR EDGAR LEDERER. (Actualites Scientifiques et Industrielles. Hermann et Cie, Editeurs, Paris.)

The author, being himself an investigator in this field, has published a succinct account of the carotinoids found in the animal kingdom. The book is based on the well-known and classical works of Palmer, Zechmeister and Verne. To begin with, is given a table of the carotinoids of plants to remind the readers of the existence of such pigments in plants. The first two chapters concern themselves with an account of the carotinoids found in several parts of the body of the invertebrates and vertebrates. The third chapter deals with the pigments specific to animals. Biological and biochemical questions are discussed in the last chapter bringing out the relationship between the carotinoids and the related pigments and Vitamin A in mammals, birds, fishes and crustaceans and its importance in medicine. The book provides a useful summary to students interested in the subject. An up-to-date bibliography is appended.

A. S. R.

1475-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.

Rural Development.

IN 1933 the Government of Bombay published an interesting brochure on Village Improvement, which contains a draft scheme for the betterment of the villager and the village,—drawn up by Sir Frederick Sykes. Recently the Government of India have sanctioned large grants to be utilised by provincial governments for rural uplift and last month Mr. R. S. Sathianathan's report on indebtedness in rural areas of Madras was published. At October session of the Representative Assembly of Mysore, Sir Mirza M. Ismail reviewed the progress of work in the advancement of the moral and material well-being of villages under the jurisdiction of his administration. Leaders of public opinion exhort the unemployed young graduates to go to the village and earn a living by serving its population. There are several semi-official and private agencies devoting their time and energies in the work of elevating the rural people. Bright days are ahead for the Indian villages. The universal manifestation of tender solicitude for the amelioration of the conditions of rural life is a phenomenon for which history furnishes few parallels. The general desire to serve the interests of the rural population is a recognition of the fact that this backwardness must retard the progress of the body politic and their insanitary surroundings must all at times be a source of danger to the public health of the village and of the urban areas. It is obvious that the indigence and indebtedness of rural population must react on the general revenues of Government and on the prosperity of industries. The isolation of large sections of population from the centres of administrative activities must account for their backwardness, and the forces which have contributed to the progress of other communities have not enriched the village life. The remedial measures suggested by Governments and others who have investigated rural problems offer hopes of speedy improvement in the lot of the village communities.

It seems to us that the problems presented by people who for ages have lived practically in isolation and have carried on rural occupations in unrelieved monotony will have to be investigated from the psycho-physical standpoint before schemes of reform for their uplift can profitably be discussed. We are not thinking of villages which lie within easy reach of administrative centres. The

physical and mental organisation of the people living from antiquity in the remotest recesses of the country may not easily be amenable to the influence of social and economic reform of governments and unemployed graduates, and the problem of these communities may not be identical with those of the more favoured people residing not far from towns. There is no ethnic homogeneity among the rural population and the success of measures devised for their uplift therefore must depend not on the forces exerted on them from outside, but on their sympathetic reaction to such measures. Are the village people thoroughly dissatisfied with their present condition? In what directions do they demand reforms? How far are they capable of supporting schemes of beneficence by their own unaided assistance?

These questions have been answered by Sir Mirza M. Ismail in his illuminating address. "It is barely eight years since the Village Panchayat Regulation was brought into force; yet in these eight years the number of Panchayats has risen from 8,863 to 11,390, the total revenue collected by them has exceeded Rs. 75,00,000 and they have already incurred expenditure exceeding 45 lakhs of rupees. The raising and expenditure of this money has not been an end in itself, but the means of conferring on our rural population a very large measure of village self-government. The Panchayats in Mysore have justified themselves not merely by the works they have undertaken, the roads they have opened, the drinking water and other wells they have sunk, the village parks laid out and the extension of medical and educational facilities, but also by the spirit of public and local pride which they have engendered. The people have come forward in numerous instances to provide weekly communal labour to improve their villages and it has been calculated that the labour so performed would have cost about rupees 10 lakhs if performed by a paid agency." The contribution of Government to the exertions of Panchayats is even more generous and is reflected in the numerous achievements of government departments which have given the villages more tanks for extending cultivation, cheap electric power for pumping installations, industries and lighting. All these schemes form a coherent part of the policy for the promotion of rural prosperity and their fulfilment is only a realisation of the political faith that "governments are called upon to undertake the control in an increasing measure of the economic life of the peoples entrusted to their care".

Mr. Sathianathan's report on the indebtedness in rural areas of Madras delineates the picture of village population in a totally different colour. The agricultural debt in the province is estimated at rupees two hundred crores, an amount equivalent to 20 per cent. of the landed estates. The report throws light on the extent of the cramping influence exerted by indiscriminate and usurious borrowing, on the development of village activities. In a certain measure it must necessarily curtail the grants for reconstructional operations, since a large proportion of the funds will have to be devoted to relieving indebtedness. The worst effect of this heavy burden is that small holdings have passed into the hands of creditors who are unable to continue the agricultural operations and the larger holdings suffer from absentee landlordism capable and willing to advance credits more in the way of investment than as a means of stimulating agricultural operations. The rural problems in a presidency such as Madras must be too complex and difficult to permit of easy solution. Debt rarely fructifies in the hands of the borrower, least of all in those of the agriculturist. Debt Conciliation Boards, if instituted and worked in the spirit in which the Bill for their formation is conceived, the cultivator may find some relief but there is nothing to prevent him from raising fresh loans. The scheme of controlled debt to which reference is made in the report, the essence of which is to provide loans of money and realise them in kind by periodic and expert supervision of cultivation, may assist in keeping the ryot on his land which is undoubtedly a great step in the general movement of rural uplift. Sir Frederick Sykes points out that debts are generally contracted by habits of extravagance and by adherence to expensive customs which the ryot has no courage to withstand. The tendency to take trivial disputes in suits to law courts involves the village population in appalling waste of money, and litigation is more often a fatal enterprise to the villager. The problem of rural reconstructions in large presidencies has a multi-lateral phase and simultaneous attack on all the fronts is proposed by governments and political leaders and the fruits of victory will be

permanent only if the village population actively join the forces initiated for their improvement.

It seems to us that there are certain other ferments stirring village life which must militate against the success of the efforts of even governments to regenerate rural welfare. The people who live in villages not far from the towns come into almost daily contacts with the attraction offered by urban life. Saints and philosophers find it hard to withstand them; the Indian villager has neither the fortitude of the one nor the discipline of the other. The increasing dazzle for town life overpowers him. The expansion of industries offers him reasonable security of engagement, regulated hours of work and protection of labour unions which supervise his education, health and comforts. He welcomes relief from anxieties inherent in his profession, which control over meteorological conditions alone can remove. The large engineering works initiated by the governments, business offices and banks and expansion of places of public amusements and restaurants are slowly absorbing the rural population. As the towns expand industrially and economically the villages naturally contract. How to arrest this depletion of villages is a question now receiving anxious public consideration.

The farmer may be educated. We may provide him with modern implements, credit and expert advice. Facilities may be created for recreation and subsidiary occupations. Every inducement which may be expected to make him happy and contented to remain in his place and cultivate the land can be offered. He finds that his output is governed by new economic laws from which he suffers as acutely in the years of scarcity as in the years of plenty. Agricultural industry is individualised and it is not a syndicate. Without resources of finance and collective power such as well-organised business can always command, agricultural communities being industrialists are confronted with fluctuation of commodity prices arising from "economic depression," "exchange ratio," "tariff rules" and all other phrases and traps. However, the phenomenon of suffering in the midst of plenty is peculiar to modern economic civilisation. The remedy seems to lie in agriculture striking up a new friendship with chemistry for profitable utilisation and disposal of surplus produce. The country which knows no waste is bound to give a new lead to civilisation. The key to rural prosperity is not external padding but research on waste. Science has created poverty amid plenty and science alone can save. It is hard to make the public realise that, but for the vested interests which have grown so immensely round our social and economic problems, science could solve practically every difficulty which confronts governments and private organisations in promoting prosperity and in improving social standard.

The process of recruiting the gifted members of the rural population and other industrial communities to public service may satisfy the principle and policy of communal representation, but it must necessarily impoverish the economic power of even the favoured families. Sir Frederick Sykes pointed out that "we must discard the idea that village betterment depends entirely on forces from without—on action independent of the will of the villager." Who is to supply this will to progress without which all schemes for the spread of material welfare and greater contentment among the agricultural population must be futile, particularly when its educated and forward members are alienated from their traditional occupations and new castes are formed having neither opportunity nor inclination for the scientific study of the development of rural occupations? When those who can revitalise the resources and energies of village life are steadily drafted for other services, the helplessness and crudity of others left behind tend to be perpetuated and the moment we withdraw external assistance, the confusion must worsen the situation. The present position in the villages is a result of the emigration of the more capable individuals of the rural population to town, attracted by inducements for bettering their prospects, held out by government service, industries and business organisations. Education has produced in all communities a thirst for soft appointments in Government Departments, but has not encouraged the spirit of service to the community and pride in family occupations.

Modernisation of Indian villages is inevitable and in order to sustain the improvements and carry it further, it is necessary that the educated young men who have been hitherto looking forward for Government service, should acquire special qualifications for rural reconstruction. An untrained

young man may turn his back on the work he has undertaken on encountering difficulties and disappointments. In several respects the problems of village improvement are technical and their satisfactory solution depends on the aptitude and training which the young men possess. It seems to us that the work of elevating the rural population will be successful if governments could organise special courses of instruction in moral sciences in the universities for the benefit of the people whose prosperity and contentment are the safest insurance of peace and progress of the country, and for the relief of unemployment among young men whose condition engages the anxious consideration of the public and Governments.

Agricultural Research in India.

THE annual report of the Imperial Council of Agricultural Research for the year 1933–34 which has just been published, is a document of absorbing interest, not only because of the large number of special schemes, both scientific and economic, sanctioned by the Council and in progress, but also because of the many more important schemes which are planned or foreshadowed. The large increase in the output of scientific research in Agriculture is an outstanding feature of the progress of scientific research in the country and the Research Council can already claim credit for much of this activity; indications are, as a matter of fact, that it will soon be the greatest single factor tending to the progress of agricultural research, thanks to the liberal grants of money voted by the Central Government for this purpose. The report refers to a temporary cessation of the annual grant owing to financial stringency which has prevented the Council from going forward at the initial pace and which has necessitated the holding up of many a sanctioned scheme. It almost looks as if it was a case of "first come, first served" and that many new schemes had no chance of being considered. A special grant of Rs. 5 lakhs towards the end of the year somewhat improved the situation, though even with this further grant, schemes already approved and costing about Rs. 11 lakhs have had to be kept in abeyance. The list of the schemes already in progress and the amount set apart for each is interesting reading, if at least to show what a vast field remains untouched. Thus out of the 41 schemes in progress, 18 relate to the sugar industry and absorb Rs. 25 lakhs out of a total of about Rs. 45 lakhs. Schemes relating to rice research absorb about Rs. 11 lakhs, and those relating to locust research cost about Rs. 4 lakhs, so that these three subjects alone take up about 90% of the total grant. One need not grudge to the sugar industry which has within the last five years undergone phenomenal development and added largely to the material prosperity of the country as a whole and of the agriculturist in particular, this large measure of help; nor to subjects like rice research and locust research, the substantial proportion they receive by reason of their great importance, but when one compares the bare 10% of the grants which remains for meeting the needs of the large variety of crops and of much-needed development in both crop and animal husbandry, the anomaly of the situation becomes rather striking, and the necessity for a substantial increase in the grants available assumes additional urgency. It is true that much water has flown under the bridge since the period covered by the report and that money has been voted for a number of new schemes, the most notable among which is the one relating to the important subject of the marketing of agricultural produce and the appointment of a chief marketing officer. Furthermore, the needs of one major crop *viz.*, cotton, are being met largely by the mill industry itself through the cotton cess fund, administered by the Indian Central Cotton Committee; a similar cess assists the lac industry; the sugar industry is also in a manner helping itself through the excise duty now being levied; the report, moreover, refers to a proposal for levying a cess on the export of oil-seeds for affording funds for research on the development of the oil-crushing and allied industries in the country. If this latter proposal should materialise, it will mean that one large group of agricultural produce will be meeting its requirements for funds from its own resources. It should, therefore, be possible for the Government of India to set apart substantial sums for research on other important branches of agriculture. As a matter of fact, some of the schemes already sanctioned, such as the marketing inquiry, will inevitably call for a much larger expenditure before long, as each survey discloses lines for suitable practical action.

The Report refers to the formation of

three separate Standing Committees for animal nutrition, cattle-breeding and dairying and also to steps taken for the investigation of important cattle diseases, during the year. The latter certainly demands much greater attention and one can hardly think of a more fruitful field for the Council's help. The livestock industry in the country is already a huge one and as the years go by, is bound to assume still greater importance from the point of view of increasing the earnings of the ryot and of improving the nation's food supply; but one of the greatest handicaps to progress is the prevalence of disease which threatens the industry on its present scale itself; while expansion or improvement in respect of breeds whether it be cattle, sheep or poultry is practically out of the question. The veterinary staff in the provinces has neither the time nor the facilities for anything beyond the routine of a general practitioner, and such research facilities as exist at the Muktesar Institute and in some of the Veterinary Colleges and Serum Institutes are disproportionately inadequate for the needs of the country. A Central Institute for this purpose, well-equipped and staffed, is a crying need and forms a legitimate demand upon central revenues. This, of course, does not rule out assistance to the provinces and existing institutions conducting researches such as the present provision of Rs. 2 lakhs for the investigation of tuberculosis and Johne's disease. We wish the scheme of sheep breeding, referred to in the report, took precedence over some others, or, was accorded special treatment and proceeded with, for the possibilities are admittedly great and the subject has been relegated to the background for a very long time. As it is, a sum of Rs. 85,000 is said to have been sanctioned for a scheme which, however, had to be kept in abeyance for want of funds. A beginning is said to have been made in the matter of registration of pedigree stock of dairy and draft cattle; a revised and uniform classification of cattle for purposes of the quinquennial cattle census has been approved by the Advisory Board, which is an improvement on the present form; a recommendation fixing a three years' course with F.Sc. as an entrance qualification in the Veterinary Colleges and a curriculum suitably revised for the course was also approved by the Board, in the Animal Husbandry Section.

In the section of crop industry, work on sugarcane occupies, as already indicated, the most important place. A chain of eight research stations in Upper India and three located in Bombay, Madras and Mysore have carried on work relating mainly to the breeding and testing of superior varieties and incidentally to other aspects of cultivation such as, manuring, irrigation and methods of jaggery making. Work on the improvement of the indigenous methods of sugar manufacture has received considerable attention as likewise the methods of jaggery making. In the face of the competition from sugar made in large-scale factories whose efficiency is being rapidly improved we doubt if the old-fashioned *Khandsari* sugar has any chance and if it is worthwhile spending money over improvements in the methods. The case of jaggery is however quite different, for not only does this product come in as a class by itself and distinct from sugar but it forms about the only outlet for the cane crop in many parts of the country which for various reasons cannot be thought of for sugar manufacture on a factory scale. Better extraction, cheapening the cost of manufacture and improvement in the appearance and keeping qualities of the jaggery, will all make it a more remunerative proposition, and afford scope for considerable research work. We would also add that the prospects of manufacturing raw sugar or refining crystals in preference to jaggery in some at least of the jaggery-boiling centres, deserves to be investigated. The appointment of a geneticist for the cane-breeding station at Coimbatore and the strengthening of the mycological staff at Pusa for the investigation of mosaic and other diseases of sugarcane during the year, are noteworthy, as likewise is the approval by the Board of a scheme for the study and control of insect pests on sugarcane. Knowing as one does how serious the position is in these matters, a more welcome feature of the year's work on sugarcane can hardly be thought of and we hope this pest control scheme will be taken up without further delay. The enquiry into the cost of production of crops in the sugarcane and cotton growing tracts in India has not been undertaken any too soon and one can say from personal knowledge that the results are sure to throw a good deal of light on a subject of great importance in the economics of agriculture on which opinions at present are vague and often contradictory. It is a matter of

gratification that the Council has boldly embarked upon this inquiry notwithstanding its cost and despite perhaps the opinions of doubting Thomas's about its value.

Research on rice occupies the pride of place, judged by the expenditure sanctioned, among the other schemes. It is a comprehensive all-India scheme costing Rs. 11 lakhs, spread over a period of five years. Work, however, seems to have related mainly to the breeding and testing of varieties which most provincial departments are already engaged upon, but the grant is said to have enabled the departments among other things, to widen the range of varieties handled. We may, perhaps, single out the work in Burma for special mention, for it relates to the development of strains of rice suitable for the English and European markets and leading therefore to an expansion in the foreign trade in rice. The period of five years is too short for the work in view, and we feel certain, that the need for continuing the scheme will have to be faced. While on the subject of foreign markets for Indian produce, we may draw attention to the collection and circulation of information by the Council during the year regarding the quality of the different kinds of produce, notably oil-seeds, which enjoy a preference in the United Kingdom markets under the Ottawa agreement, which will enable them to compete with non-empire produce and will make the preference really operative. We are glad that as an all-India organisation, the Council has been fully alive to the importance of this matter and is closely watching the working of this commercial agreement in the interests of Indian agriculture.

It is rather disappointing that in respect of tobacco where the scope for improvement with a view to meeting the local demand for cigarette tobacco and also producing enough for an export trade is very considerable, the Council could not do more than appointing another committee. We hope this committee's work will lead to practical action very soon, among which we may suggest suitable financial help to provincial departments undertaking the cultivation of the special varieties and the curing and conditioning of the produce according to up-to-date methods.

Among the minor activities of the year, we may refer to the subject of statistical studies in agricultural research and the help afforded by the Council in the training of agricultural officers in these methods. The field trials and the interpretation of the results stand to gain in accuracy and already the effect of the training is noticeable in the studies and publications of many of our experiment stations. The initiation of studies in agricultural meteorology is another important development to the credit of the Council and considerable work has been done especially in correlating crop yields to meteorological data and in the evolving of suitable instruments and of technical methods. Weather Bureaux elsewhere have been of such great assistance to farmers that we can expect our own organisation also to play a similar rôle, provided the staff is strengthened so as to secure co-ordination with the existing meteorological stations in the different parts of the country.

It will be impossible to refer even briefly to all the schemes and other activities of the Council. The oil technology work and the work on the utilisation of molasses at the Harcourt Butler Technological Institute, the work on the utilisation of town refuse and farm waste for manure at the Indian Institute of Science, potato breeding on the Nilgiris, inquiry into the trade in cocoanuts and cocoanut products, locust research, water hyacinth control, dry farming schemes, goat keeping, 'quality' in crop investigations, malting of cholum, fruit research schemes, research on virus diseases, are some of the schemes referred to in the Report. As already indicated, however, nearly all the schemes have been going on only for short periods and some have hardly begun. Moreover the Report itself, latest as it is, appears to be very incomplete; so rapidly have the activities of the Council been expanding and so many are the new schemes taken up since the period covered by the Report. The Council is gradually approximating in scope and organisation to the Federal Department of Agriculture in the U. S. A., and we have no doubt that the Council will succeed in doing as much for our agriculture as the U. S. Department is doing for the American farmer.

Poverty amidst Plenty.

THE paradox of Poverty amidst Plenty has become almost a platitude by iteration. Nevertheless the conscience of thoughtful people continues to be disturbed. Why is food thrown into the sea when

millions are ill-nourished? Why is cotton ploughed into the soil when millions are ill-clad? There are those who blame the discoveries of modern science for this trouble, the means of production have vastly increased while distribution has lagged behind. The problem would seem indeed to be largely a question of time-lag. Part of the world is living mentally in the age of the bullock cart, part in the age of the aeroplane. Thus the financial world is still largely governed by the ideas of a pre-scientific era and is therefore ignorant of the implications of modern science. The scientific worker, on the other hand, is little concerned with the world of finance and the possible results of his own discoveries, in relation to the public welfare.

It is satisfactory, therefore, to note that at last the scientific world is waking up to the need for the realisation by scientific workers of their responsibility for the wider aspects of human welfare, lest science itself shall come under condemnation. A recent letter of protest against the misuse of scientific discovery has appeared in the press bearing the signature of the President of the Royal Society and a number of other distinguished names. Sir Richard Gregory speaking recently at a Rotary luncheon at Norwich made an eloquent plea for the right use of the gifts of science, and looked for the time when science would no longer be thought of as a destroying angel but as the herald of a more abundant life.

Following a recent discussion at Oxford on "Academic Freedom", reported in the August number of the *Journal of the Institute of Chemistry*, a resolution was passed to set up a Committee with the object of seeing that so far as possible science should be used only for the benefit of humanity. Of even greater significance than protest and eloquence is the fact that a representative body of engineers and scientific workers of the British Science Guild have formed themselves into a group to study the problems of modern economics and these studies have resulted in the publication of a highly valuable document entitled "First Interim Report on Schemes and Proposals for Economic and Social Reforms". No fewer than 24 proposals have been carefully studied and their essential features tabulated. Among these proposals may be specially mentioned :—

Sir Basil Blackett's "Planned Money",
Proposals of the Communist Party,
Conservative Party Proposals,
Douglas Social Credit Proposals,
The Proposals of Silvio Gesell ("Free Economy"),
The London Chamber of Commerce Proposals,
Professor Soddy's Proposals, and
The Proposals of the Continental Committee on Technocracy.

The British Science Guild have published other pamphlets of scientific and economic interest among which may be mentioned "The Electron Liberated: Its Industrial Consequences", by Clifford C. Paterson, O.B.E., M.Inst.C.E., M.Inst.E.E., and "Human Biology and Politics" by Professor J. B. S. Haldane, M.A., F.R.S.

This activity among scientific workers may help to lay a true foundation for a new world where every hungry mouth has enough to eat, every capable hand enough work, where exploitation in the name of business is unknown and where peace and sufficiency reign supreme.

The appeal made by Dr. Fowler in his recent paper entitled "Energy and Economics" which appeared as a supplement to the May number of *Current Science*, calling for greater attention on the part of scientific workers to the problems of modern economics, has our warm support, and we hope to return to the subject in a later issue.

Rajasabhabhushana Sir Chandrasekhara Venkataraman, Kt., F.R.S., N.L.

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HIS Highness the Maharaja of Mysore was graciously pleased to confer the title of "Rajasabhabhushana" on Sir Venkataraman at the recent Dasara Durbar held in Mysore. We have great pleasure in congratulating Sir Venkataraman on the glittering decoration bestowed on him. Palace honours are usually reserved for officers rendering distinguished service to the State, and the titles connote the merits and accomplishments of recipients. But in the case of Sir Venkataraman, all laurels become his brow. His Highness's generous act will be widely appreciated.

Geochemistry and Biochemistry.

By Prof. A. P. Vinogradov.

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I.

UNTIL quite recently, it was generally believed that organisms—plants and animals—consisted of a very limited number of chemical elements.

This view has, now, to be abandoned, since 60 chemical elements have been discovered in one or the other of the organisms ; it is, perhaps, easier to name those chemical elements which have not been found in organisms or about which indications are unreliable. The chemical elements not yet discovered in organisms may be referred to five groups : (1) the radioactive elements Pa, Ac, Po and the numerous radioactive isotopes* ; (2) the rare-earth metals—Tl, Eu, Gd, Tb, Dy, Ho, Er, Tm, Il and Lu ; (3) the inert gases He, Ne, Kr, X ; (4) the elements of the platinum group : Ru, Rh, Pd, Os, Ir, Pt § ; and (5) of all the other chemical elements : Te†, Zr†, In, Ta, Hf, Ma, Re, 85† and 87†.

This list shows with sufficient conclusiveness the present position. For the majority of the chemical elements named, there are yet no simple and sufficiently sensitive and accurate methods of determination. It may be conjectured that these elements may be found in organisms only in negligibly small amounts.

Nevertheless, the constant finding of one or the other chemical element, often in small amounts (in thousandth, millionth and lesser parts of a per cent. ; they may, therefore, be called microelements), in the tissues of organisms, was not a convincing indication for biochemists, of the important physiological part of those "traces" of microelements. Scores of years were required after I, Cu, Mn, B and many other microelements were found in organisms, to recognise their important rôle in physiology.

The exceptional interest of the question of the physiological rôle, in particular, of microelements present in the tissues of organisms, arose recently among biochemists (physiological function of Cu, F, B, etc.) and especially among agrochemists (importance of B, Cu, I, etc. for plants).

As in the past, the many-sided researches in this direction, which are conducted by various specialists, physiologists, biochemists, chemists, agrochemists, mineralogists, etc., are being carried out along different paths, and pursue quite different objects. Owing to this there has occurred a certain break. The unique common phenomenon—the process of shifting matter, the *biogene migration* of atoms in the complex *indissoluble system —soil—soil solution—plants—animals,*— was lost sight of by these investigators.

II.

Not less persistently, is the view held that the *chemical elementary composition of organisms* does not represent any differences as to species, genus, etc. ; that it is not constant and is subject to considerable variations. In other words, we cannot definitely consider it proved, that the chemical elementary composition of organisms is a specific character. It must be noted, however, that from this point of view, the subject has not been systematically investigated.

The study of the chemical elementary composition of living organisms has been, in a way, the special interest of the physiologist, biochemist, agrochemist and mineralogist. The importance of the problem is only being recognised at present. And, nevertheless, many scores of thousands of analyses of various organisms made during a period of more than a century, by agronomists, biologists and mineralogists, on closer examination, contain direct proof of special features, and of a certain constancy in the chemical elementary composition of species.

For instance, the differences in the contents of phosphorus and nitrogen in plants and animals are very well known. Among organisms are known to us numerous species,

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* Besides MsTh, see works from our Laboratory—V. Vernadsky, B. Brunowsky and Kunaseva, *Compt. Rend. d. Sci. Acad. Paris*, 1933, T. **197**, 1556.

§ It is of interest to note that Ge was discovered in organisms recently by V. M. Goldschmidt within the ranges indicated in the curve. Into the maximum enters Ru, one of the elements of the platinum group, which forms soluble compounds more easily than others. In the smallest amounts is probably found Th.

† Indications not checked, but their occurrence in organisms is known.

which concentrate definite chemical elements in considerable amounts. We are familiar with the division of plants into the calcareous and siliceous ones. Among the latter are, for instance, the grasses, sedges, horsetails, and diatoms. We know perfectly well the typical iron-organism (also that of manganese, sulphur, etc.); the halophytic flora (Na and Cl), numerous hydrophites, which collect considerable amounts of aluminium ‡ (marine and fresh water algæ, many aqueous phanerogamous plants—monocotyledons, bacteria, etc.), and the like.

In relation to many chemical elements it might be possible to indicate typical organisms—concentrators. It is possible to easily discover the peculiarity of the chemical elementary composition of definite species of living organisms by comparing the composition of different plants for which numerous determinations have been made, especially for the composition of their seeds. In the Biogeochemical Laboratory of the Academy of Sciences of USSR investigations were made on the chemical elementary composition of 13 species of *Acridiidæ*, collected from various localities during a period of three to four years. These data have shown a complete stability of the composition of *Acridiidæ*, its resemblance to proximate species and very great distinctions from the chemical composition of other insects. Sometimes, in animals, the definite occurrence of only one chemical element acquires a specific character. For instance, investigation of 20 species of ants has shown us, that the species of the family *Camponotinæ* contain Mn of an order N. 10^{-2} per cent. but species of the family *Myrmicinæ* of an order N. 10^{-3} per cent., while the more primitive family *Ponerinæ*, as it seems, contains still less Mn. Another instance: ascidians are rich in vanadium. They are typically vanadium-organisms. Nevertheless, as we have shown, not all the species of ascidians concentrate vanadium. Species from the families *Ascidiidæ*, *Cionidæ*, *Botryllidæ* and some others concentrate vanadium, whereas the majority of species from the families *Tethyidæ*, *Melgulidæ*, *Synoicidæ*—do not contain any marked amounts of vanadium. Similarly, among the families and genera of living organisms rich in vanadium, manganese, iodine, copper, etc., are distinguished species exceptionally rich in one or the other chemical element. The number of such instances may be multiplied. We have quoted them in our work on the chemical elementary composition of marine organisms.

Fluctuations observed for the chemical elementary composition of organisms may be accounted for as being due to age, season, sex and ecological factors. The individual fluctuations of the chemical elementary compositions recall similar fluctuations of the morphological characters in organisms.

Thus, there certainly exist typical differences in the composition of definite species, genera and other taxonomic units.

The chemical elementary composition of organisms is a species character.

III.

The chemical elementary composition of organisms or the finding of one or of another element in the tissue of these organisms has been studied by biochemists, as a rule, outside its natural environment—the biosphere.

Between the environment and the organisms there occurs, uninterruptedly the exchange of matter—the environment and the organisms are closely connected by the common history of the atoms of the chemical elements. *Living matter* (totality of all organisms) during more than one million years has shown enormous geochemical activity, by concentrating various chemical elements, by playing a considerable rôle in sedimentary rock formation. In the chemical composition of each organism we encounter the expression of a definite geochemical part played by the given species of living organisms. From a geochemical point of view, some *geochemical functions* are inherent to all organisms—in some the calcareous geochemical function predominates, in others the siliceous or phosphate one, and so on; and, finally, several such functions may take place together. The chemical elementary composition of organisms and therefore the range of participation of the organisms in the biogene migration of the chemical elements in the biosphere cannot be left without attention when studying the geochemical laws of the distribution, combination and migration of atoms within the earth's crust. For the first time, the *biogeochemical* ideas indicated were stated with exceptional vividness by Prof. V. I. Vernadsky. From that moment the question of the chemical elementary

‡ Contemporary *Licopodiacea* are rich in Al. Probably the fossil *Lepidodendron*, which are closely related to the latter, were also rich in Al. Their coal is rich in Al.

composition of organisms acquired a full scientific value. And the closer we approach it, the more obvious becomes the fact that the general geochemical laws, governing the distribution and combination of the chemical elements in the earth's crust govern also all living matter.

IV.

We have got accustomed to the biogene migration of atoms between organisms and environment, which is occurring in the biosphere during scores of thousands of years. We do not notice this close, indissoluble, unchanging (within historical time) connection between them. It becomes manifest as soon as a disturbance occurs.

We often come across such biogeochemical phenomena.

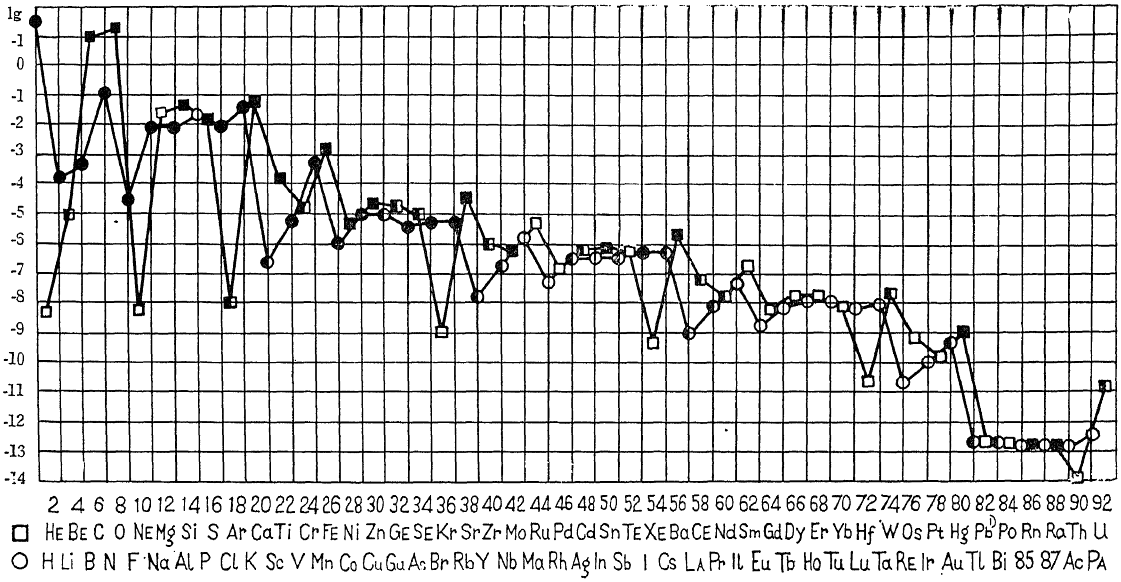
The *deficiency* or *excess,* as compared with the usual presence in the environment, for instance in soils, of some definite chemical elements, owing to the peculiarity of the geochemical history of the given locality, calls forth, over tremendous areas, a change of the qualitative and quantitative morphological composition of the soil cover and of the animal world connected with it. It is well known, for instance, that the deficiency of Ca, P, (for instance, in soils originating from granite) calls forth a disturbance in the composition of the flora. Thus, for instance, the grasses of the Savannahs and steppes experience phosphate hunger, etc., and in their turn the steppe animals, cattle from the pastures, become sick because of deficiency of phosphorus (and lime) (inflammation of the bones, "brittle bones"). Those phenomena are observed also on cultivable soils throughout the whole world. The deficiency of Fe (and Mn) in the soil leads to sickness of both plants and animals. Perfectly well known is the spread of endemic goitre among men, cattle, birds, fishes, etc., in localities with a deficiency of iodine in the soil, drinking water, etc. At present, in many countries (Holland, Germany and others) are known soils demanding Cu for the successful growth of crops. The absence of Cu in the feed, appears to cause in cattle a special sickness (licking disease). Many soils, as it has now become evident, demand for the normal growth of some crops—leguminous plants, flax and the like—a definite ınt of boron. On the contrary a ·xcess of one or another chemical soil, leads to similar *geo-* ·es occupied by peculiar *biogeochemical endemies.* We know of Se, As, and other "poisonings" of some soils. The excess of F in soils, soil waters, in drinking water in many countries—U. S., Algiers, Tunis, and others—causes an endemic disease of man, the so-called "mottled enamel", and so on. Much in this direction we still do not know. Similar biogeochemical endemies connected with the presence in the soils of Zn, Al, serpentine and others have a lesser range. All this leads to the formation of peculiar variations in some definite plants from these soils. It seems to us that the existence of regions (soils) with an unusual content of some chemical elements, forming geochemical provinces or separate "spots", should prove a kind of hindrance for the spreading of definite species of organisms.

Therefore, such geochemical provinces have the property of a selecting and transforming factor for organisms. In the process of their life and evolution, plants and animals in their turn (in a geological sense) lived on a definite substratum which formed only one of the stages.

Thus, it seems to us, that in each *species of organisms are concealed the chemical characters of their origin.*

The study of the chemical elementary composition of organisms from a geochemical point of view helped us to arrive at some general conclusions. The average chemical composition of living matter may be graphically expressed in the form of a curve (see Fig. 1). Comparison with similar curves for the distribution (frequency) of *atoms* in the soils, earth's crust, living matter, etc. shows that at their basis lies one general law of quantitative distribution of atoms. However, they differ in details. Each of the paragenetic spheres (living matter—biosphere) is characterised by its peculiarities. We see from the curve for the distribution of chemical elements in the living matter that: (1) the number of atoms of chemical element in the living matter is in inverse proportion to its atomic number (atomic weight). In other words, the chemical elementary composition of the living matter, as a whole, is definitely related to the number of charges on the nuclei (protons). (2) The curve shows a regular periodicity (6 and 8) with definite maxima and minima, representing certain regular deviations from the hypothetical inclined curve (which may be traced from H to U). Periodicity for the number of atoms in living matter is

Chemical Elementary Composition of Living Matter (in per cent atoms).



■ ◧ □ – even number
● ◐ ○ —odd ,,
■ ● —quantitative data
◧ ◐ —qualitative ,,
□ ○ —probable ,,

Fig. 1.

accurately observed within the ranges of the first 50–60 elements, for which experimental data exist. The curve can be extended further; few data exist for the remaining chemical elements—Au, Hg, Ra, Th, etc. (3) The chemical elements which occur in maximal quantities play the chief part in the composition of organisms. In relation to those elements numerous organisms—concentrators,—are known. They are especially varied and numerous among the representatives of ancient groups of organisms (*Tallophyta*, *Protozoa*, etc.). The elements, occurring in minimal quantities, are not concentrated by organisms. From a geochemical point of view those elements—inert gases, Hf, Zr, Th, Rh, Se, partially Ti, and others—are characterised by a nearly complete absence in them of the capacity to form soluble compounds (in soil, etc.)* in natural conditions.

Thus the range of deviation from the straight inclined line (appearance of maximum and minimum) for different elements depends on the chemical properties of atoms (outer electrons of atoms). Therefore, those maxima and minima occurring in definite species find places on the curve and although they may vary in the position, they nevertheless do not disturb the general periodicity of the curve.

In the future a more detailed study of the distribution of the chemical elements in the organisms from a geochemical point of view shall allow biologists, physiologists, agronomists, geochemists, etc., to tackle important problems of natural science using a common scientific language.

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3. A. P. Vinogradov, *Transact. of the Biogeochemistry Laboratory*, 1935, **3**, Leningrad-Moscow.

4. *Idem.*, Vol. IV (in the press).

5. Works of the Laboratory are printed in *Transact. of the Biogeochemistry Laboratory* and in the *Compt. rend. de l'Academy d. Sc. USSR.*, 1926-1935.

Some Recent Work on Isotopes and Hyperfine Structure of Spectral Lines.

By Prof. B. Venkatesachar, M.A., F.Inst.P.
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THE chemical and physical properties of an element are in the main determined by its atomic number. All elementary substances having the same atomic number but different mass numbers constitute a group of isotopes and occupy the same position in the Periodic Table. According to this definition of an isotope, H^2 (deuterium) and H^1 (ordinary hydrogen) are to be considered as two isotopes of hydrogen. Here, however, the difference in properties between the two isotopes is more marked than with other isotopes. This difference results from the pronounced inequality in the masses of H^2 and H^1.

The isotopic constitution of elements has been investigated mostly by Aston, Dempster and Bainbridge with the aid of mass spectrographs, each using an instrument of his own design. In all these instruments a mass ray containing charged atoms of the element has to be produced. For the production of such rays the existence of suitable volatile compounds frequently becomes a necessary preliminary condition. The search for such compounds has retarded the successful isotopic analysis of several elements. Of such elements palladium, iridium, platinum and gold stand prominent.

HYPERFINE STRUCTURE OF SPECTRAL LINES.

Spectral lines which appear single in spectroscopes of low resolving power often exhibit a structure when instruments of high resolving power are used, *i.e.*, in place of a single line a group of lines with small differences of wave-lengths is seen. Pauli was the first to make a fruitful suggestion to account for the hyperfine structure. In the light of subsequent theoretical development the suggestion of Pauli is equivalent to attributing a spin to an atomic nucleus: the interaction of the resulting nuclear magnet of comparatively small magnetic moment with the rest of the atom considered as a magnet would have the effect of splitting multiplet levels into bunches of close levels, the resulting transitions giving rise to the observed hyperfine structure. Taking I to represent the nuclear spin moment and J, the resultant mechanical moment of the rest of the atom, there will result $2I+1$ or $2J+1$ hyperfine levels according as $J>I$ or $I>J$. It is found that only isotopes with odd mass numbers have a nuclear spin, the even isotopes having zero spin moment. Though the spin of the even isotopes is zero they do not give rise always to coincident spectral levels. The separation of the levels in any case due to the even isotopes is called even isotopic displacement (Fig. 1). In the case of an odd isotope for purposes of evaluating isotopic displacement the centre of gravity

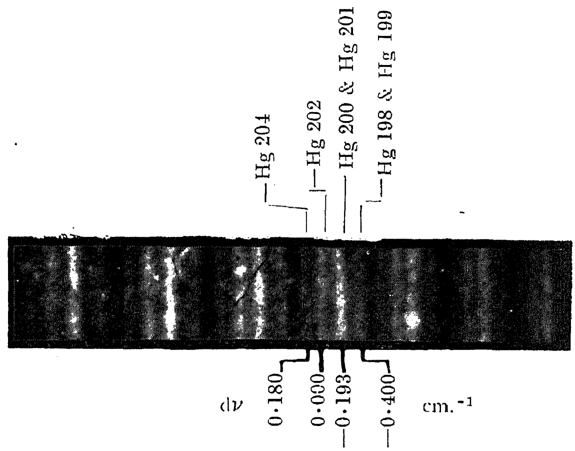

Fig. 1.
Structure pattern of Hg II 2262·33Å ($5d^9\,6s^2\ {}^2D_{5/2} - 5d^9\,6s\,6p\ {}^2D_{5/2}$) showing isotope displacement.[1]

of the hyperfine levels is taken. This displacement of levels has an origin different from that due to a change in the mass of the nucleus in the expression for the Rydberg constant, the latter may be called a pure mass effect. It may be remarked that the doubling of the lines in the atomic spectrum of a mixture of H^2 and H^1 has its origin in the variation of the nuclear mass, in other words it is a pure mass effect.

In the laboratory of the author investigations on the hyperfine structure of the lines of the elements palladium, iridium, platinum and gold were undertaken with a view to determine their isotopic constitution and the nuclear spins of the odd isotopes. Sufficient theoretical and empirical information regarding the nature and origin of the hyperfine structure to enable one

[1] Venkatesachar and Sibaiya, "Hyperfine Structure of some Hg II lines," *Proc. Ind. Acad. Sci.*, 1934, **1**, 8.

to make such determination is available provided the structure patterns can be photographed without complications arising from self-reversal. Since the significant lines for this purpose arise from transition to the ground-level or levels very near it, avoidance of self-reversal becomes a matter of some difficulty. The following arrangement of apparatus has been evolved for the purpose as the result of a considerable amount of investigation.[2]

DESCRIPTION OF APPARATUS (Fig. 2).

The hollow cathode employed in this investigation is a double-walled copper cylinder hard-soldered at both ends with the inside hollow about 1 cm. in diameter and 6 cms. in length. Inlet and outlet tubes are provided so as to maintain a continuous flow of water in the space between the two cylinders during excitation. On to the shoulders cut in the outer copper cylinder are fitted pyrex glass tubings with a quartz window on one side and a ring anode on the other. The metal glass joint is rendered air-tight by Apiezon sealing wax and due to the continuous flow of water in the hollow cathode the joint continues to be air-tight under all conditions of discharge. The apparatus is set up *in situ* with a thin cylinder of the metal under investigation fitting tightly in the hollow cathode. The apparatus is next exhausted with a mercury diffusion pump backed by a Cenco Hyvac pump. The backing pump is then cut off and the activated charcoal is cooled by liquid air contained in a triple wall Dewar cylinder. Helium is now let in slowly, further purification being effected by its passage through the liquid air-cooled charcoal. When the required pressure of helium (about 1 or 2 mms. of mercury) is reached the supply is cut off. Requisite amount of helium is thus allowed to circulate continuously through the hollow cathode by the operation of the diffusion pump. The repeated passage of helium through the liquid air-cooled charcoal maintains its purity. A direct current dynamo of 1 kilowatt capacity is employed to send a discharge through the hollow cathode. For the excitation of the arc lines a discharge current of 150 mA at 1500 v. is found satisfactory. At this stage the hollow cathode glow is intense and is accompanied with little or no positive glow. The discharge conditions can be maintained steady for hours together by replenishing the liquid air from time to time.

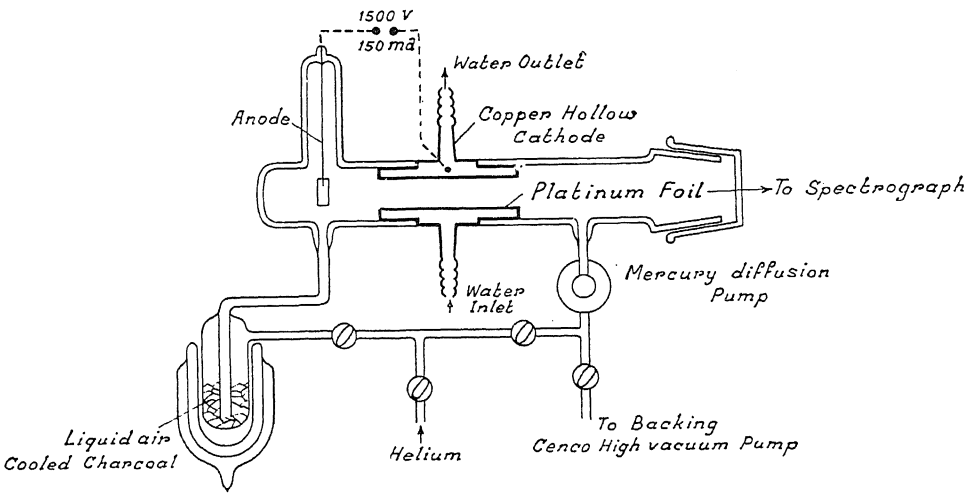

Fig. 2.
Hollow Cathode Source.[2]

The hollow cathode glow is concentrated on a Hilger Lummer Gehrcke plate of quartz (3·45 mms. thick and 20 cms. long) by means of a quartz lens carrying a double-image prism. One of the images is cut out and the light of the other, with its electric vector parallel to the plate, passes through. The pattern is focussed by a quartz achromatic lens on to the slit of a Hilger E1 spectrograph with a quartz train. The hyperfine structure patterns of the arc lines are

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[2] Venkatesachar and Sibaiya, "Platinum Isotopes and their Nuclear Spin," *Nature*, 1935, **136**, 65; *Proc. Ind. Acad. Sci.*, 1935, **1**, 955.

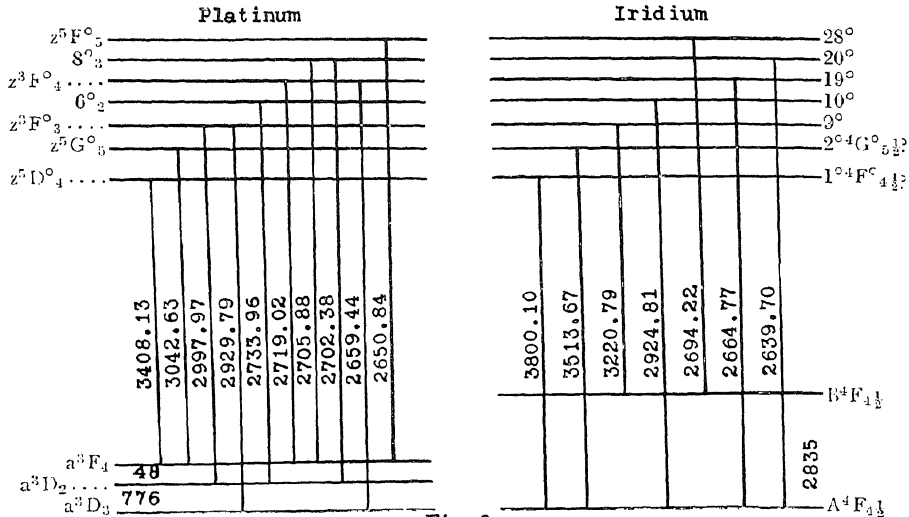

Fig. 3.

Arc lines of platinum and iridium analysed. (Not to Scale.)[4]

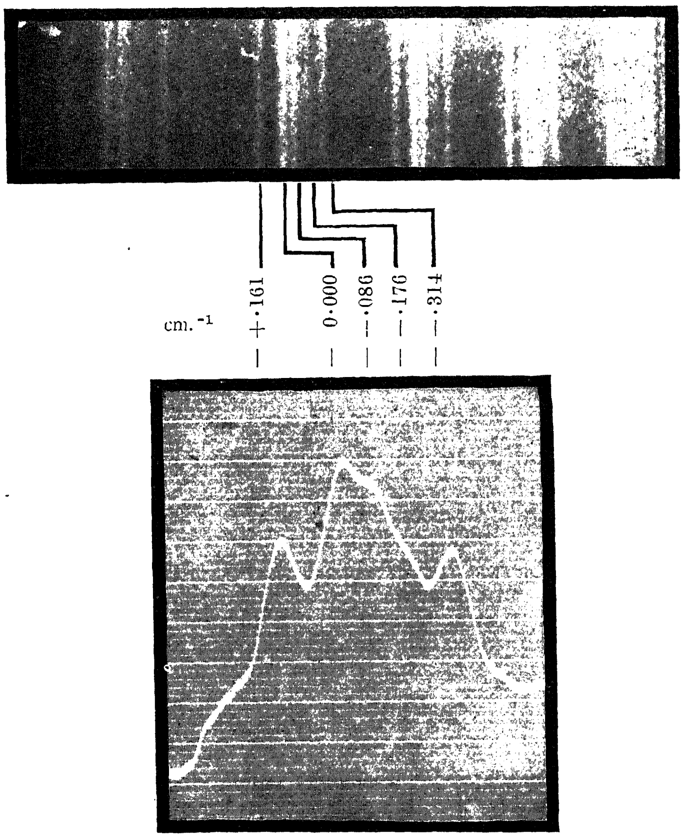

Fig. 4.

Structure Pattern of Pt I λ 3408·13 Å with Microphotogram.[2,3]

photographed on hypersensitive panchromatic plates.

The advantage of the experimental arrangement used is that only the lines cor-

responding to transitions to the ground-level or to the levels close to it are excited without introducing complications arising from self-reversal. From the standpoint of hyperfine structure analysis these are generally the significant lines. For platinum and iridium the transitions giving rise to the lines excited are shown in the diagram above (Fig. 3).

Platinum.—The photograph of the structure pattern of the line Pt I 3408·13 Å ($a\,^3F_4 - z^5D°_4$) has five components. In interpreting this pattern, the structures of other lines of platinum have been taken into account.[2] The result of the examination is that the extreme components on either side are due to the odd isotope of mass number 195 with a nuclear spin of ½ and the three inner components are due to the even isotopes of mass numbers 196, 194 and 192. The relative abundance as deduced from measurements on a microphotogram (Fig. 4) is as follows[3] :—

Mass number ..	196	195	194	192
Relative abundance	16	13	10	2

Dempster has recently published* the isotopic constitution of platinum obtained by using a spark discharge between platinum electrodes and a new type of mass-spectrograph. He finds five isotopes; according to him the isotopes 194, 195 and 196 are nearly equal in abundance, isotope 198 is distinctly less in abundance and isotope 192 occurs in very small amounts. One would infer from this that the component ascribed to 192 may be due to the isotope 198 recognised by Dempster. This, however, would give a negative isotope shift instead of a positive one. The centre of gravity of the lines due to an odd isotope lies usually nearer the line due to the lighter even isotope. This rule would be violated if the faint component in the pattern of 3408 Å is attributed to isotope 198. The isotopes 194 and 196 are however markedly unequal in abundance and cannot be said to be nearly equal as would appear from the communication of Dempster to *Nature*.

Iridium[4].—The structure pattern of the line Ir I 3513·67 Å ($5d^8\,6s\,^4F_{4\frac{1}{2}} - 5d^8\,6p\,^4G°_{5\frac{1}{2}}$) is shown in the photogram (Fig. 5). The relative intensities and number of the hyperfine components in the patterns of the lines

[3] Venkatesachar and Sibaiya, "Isotope Abundance in Platinum," *Proc. Ind. Acad. Sci.*, 1935, **2**, 101.

* *Nature*, **1935**, **135**, 993.

[4] Venkatesachar and Sibaiya, " Iridium Isotopes and heir Nuclear Spins," *Proc. Ind. Acad. Sci.*, **1935**, **2**, **203**.

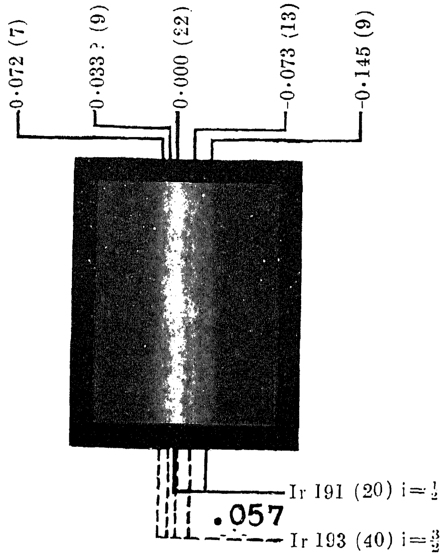

Fig. 5.
Structure pattern of Ir I λ 3513·67Å.[4]

examined and the fact that iridium is an element of odd atomic number with its atomic weight in the neighbourhood of 193 leads to the unique interpretation that iridium consists of two isotopes 191 and 193 with a relative abundance of nearly 1 : 2. The nuclear spin of the isotope 191 is ½ and of 193, 3/2. Isotope 193 gives rise to the four dotted components *a*, *b*, *c* and *d* shown in the figure and isotope 191 gives rise to the two " full " lines A and B in the case of λ 3513·67 Å (Fig. 6).

Palladium.—Using the apparatus above described, Sibaiya who has collaborated with the author in this work has examined the hyperfine structure of the arc lines of palladium and gold.[5] Analysis of fourteen arc lines of palladium belonging to the transitions $5s\,^{1,3}D - 5p\,^{1,3}(P, D, F)$ has revealed an absence of structure in the lines leading to the inference that none of the levels concerned shows any even isotope displacement. An examination of known isotopes in the neighbourhood of palladium indicates that an odd isotope of mass 105 should exist in palladium. The hyperfine structure data show that the percentage abundance of this isotope exceeds 10%, and that its nuclear magnetic moment is small. The nuclear spin of Pd 105 cannot be fixed with certainty but the value ½ is probable. The absence of even isotope displacement in

[5] Sibaiya, "Hyperfine Structure in Selenium, Palladium and Gold," *Proc. Ind. Acad. Sci.*, 1935, **2**, 313.

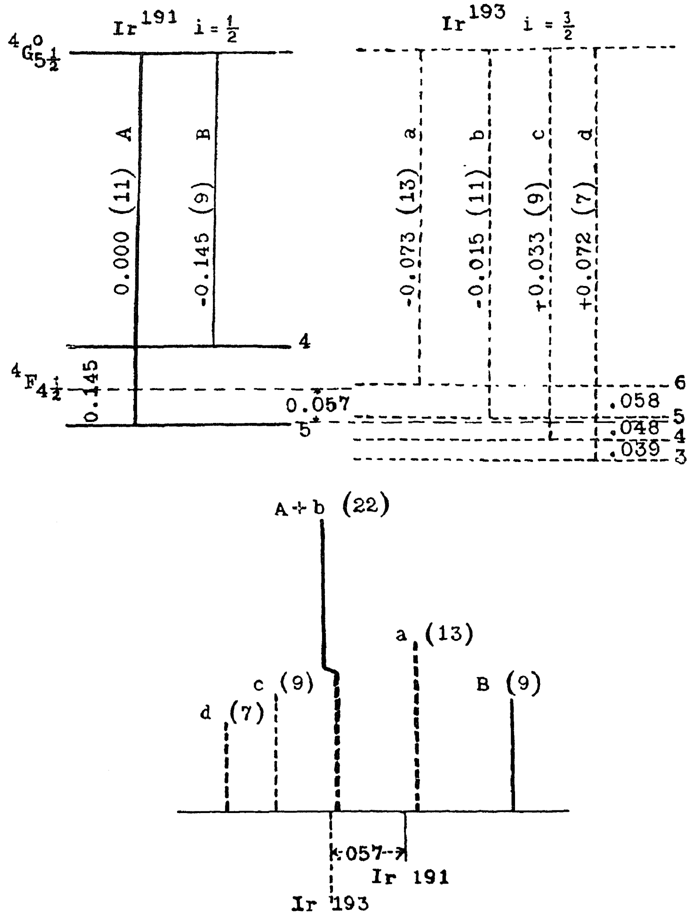

Fig. 6.

Ir I λ3513.67 Å ($5d^8 6s\ ^4F_{4\frac{1}{2}} - 5d^8 6p\ ^4G^o_{5\frac{1}{2}}$)

palladium has rendered the determination of its isotopic constitution from a study of the hyperfine structure of its arc lines alone not possible. Recently Dempster has reported† six isotopes for palladium with masses 102, 104, 105, 106, 108 and 110. The four middle isotopes are nearly equal in abundance, while Pd 110 is markedly less abundant and Pd 102 is the least abundant in the group.

Gold.—Arc lines of gold involving the level $5d^9\ 6s^2\ ^2D_{5/2}$, which shows large isotope displacements in the isoelectronic spectrum of Hg II, have been analysed. The results show definitely that gold consists of a single isotope of mass 197 with a nuclear spin of $\frac{3}{2}$ and a nuclear magnetic moment of 0·20. The accepted chemical atomic weight of gold suggests however that gold must have another isotope of mass 199; known facts regarding the occurrence of odd isobares, along with the hyperfine structure data, point to the conclusion that Au 199 is entirely absent. Thus it follows that the chemical atomic weight of gold is too high. The more recent mass-spectrographic results of Dempster corroborate the above conclusions. The experimental value of the nuclear g(I) factor, *viz.*, 0·136, is in good agreement with Landé's theoretical value, 0·133.

In conclusion one may remark that platinum, iridium and gold are perhaps the only elements, whose isotopic constitution has been first revealed by a study of the hyperfine structure of the spectral lines.

† *Nature*, 1935, **136**, 65.

Tree Ring Dating of Archæological Finds.

By R. Maclagan Gorrie, D.Sc.
(*Indian Forest Service.*)

THE reactions of the annual rings of wood laid down in the ordinary process of a tree's growth have been known for long to show some definite relationship to the climatic conditions under which the tree has grown. The credit for employing timber rings as a means for the accurate dating of prehistoric monuments goes to an American worker, Dr. A. E. Douglass, of the University of Arizona. By profession an astronomer, he first became interested in tree ring data in an effort to locate sun-spot cycles through the drought periods associated with them. Beginning as a casual enquiry into climatic influences, it developed into an appreciation of the valuable and accurate record which tree rings can add to local climatic history, and was then applied to the accurate dating of many of the pre-historic Pueblo ruins and cliff dwellings of the American South-West.

These relics of a past civilisation had long intrigued archæologists, but there was much doubt and argument over their actual age until tree ring dating changed speculation into hard fact. Some of these cliff dwellings were thought to be as old as 1000 B.C., but the earliest so far excavated has now been definitely dated 919 A.D., showing an error of almost 2000 years on the previous calculations based on other archæological matter. So accurate is this method of dating that the years of construction and occupation of individual houses have been worked out from the charred remains of roof timber and from unconsumed charcoal fuel. The Pueblo building activities are shown to have fallen off with each drought period until a great drought in the years 1276 to 1299, which was so severe that it completely destroyed most of their agricultural system of small inundation canals.

During a recent visit to America I had the privilege of studying Dr. Douglass' methods at Tucson, Arizona, and was much impressed by this example of scrupulous exactness in detailed research; so, a short account of the technique of his tree ring dating should be of some interest to scientific workers in various fields. Starting with the identification of individual year-rings in different trees from the same region, a calendar was gradually built up dating from living trees as far backwards into the past as contemporary trees or recently felled stumps would reach. It was found that the very arid and severe climatic conditions of the South-West were more or less common throughout eastern Arizona and western New Mexico, thus including the whole of a large zone of early Indian activity in the Colorado and Little Colorado basins, and extending further east into the Rio Grande basin. Throughout this vast area the main periods of drought have been a general experience, so that a characteristic pattern of the rings in any tree living in such a period becomes recognisable as a "signature".

Individual trees of course show minor inconsistencies, and in a completely canopied forest a sudden access of light to a crown by the death or removal of its neighbour trees will probably produce a wider ring than could be credited to any small increase in moisture. Actually most of the western yellow pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga taxifolia*) which have yielded the best data have grown in a very open forest type, for the country is so arid that it can best be described as an open dry savannah of scattered pine and juniper trees standing in open grass-lands, not unlike the dry *rakh* of the Punjab and Central India except that the tree species are mostly conifers instead of Leguminosæ. Just how far such data from moister and close-canopied forest types would be serviceable is doubtful, for Dr. Douglass' attempts to extend his tree ring chronology into the moister Californian forest types, with their temptingly long-lived species such as *Sequoia gigantea* and *sempervirens*, have not been so successful. The easier the growth conditions for the individual tree, the less it reacts in its growth to the hardship of individual years of drought, *i.e.*, it is "complacent" while the tree living in more trying conditions is more "sensitive" in its registration of drought years.

From present-day specimens the data can be carried back into the past by searching for timber from old dwellings, comparing their records, and linking them by "cross-dating" them to the ring patterns of known age. Gradually a series can be built up,

the outer rings of such old logs being matched with the oldest parts of modern trees. Small specimens can be cut from living trees with a simple boring instrument such as the Pressler's borer, which extracts a thin sliver of wood 1/8″ thick and showing the rings upto 3″ from the living bark. This, however, is not strong enough to sample the indurated wood of very old logs, and Dr. Douglass has used as a borer a steel tube 1″ in diameter with saw teeth at the end, which extracts an 8″ sample. Where a butt or stump is exposed, a triangular sample of the whole series of growth rings can be taken by making two slanting saw cuts across the face through the heart of the log, thus nicking out a piece on which every ring is exposed in cross-section.

In the actual analysis of rings, complications commonly met with are first, that small rings may be missed altogether, and second, that the double rings frequently caused by two wet seasons in one year may be mistaken for two annual rings. These can only be recognised after considerable practice, double or false rings having no sharp edge of ripened and flattened cell-walls such as characterise true autumn wood. This feature of false rings is a common source of inaccuracy in forest statistical work when doing ring counts to calculate the period of time required to grow trees of a given diameter, and even after considerable experience in wood anatomy one is liable to be misled. The only way to ensure accuracy, therefore, is to build up a chronological table of ring patterns from so many samples that the elusive microscopic ones and the locally common false ones are cancelled out over as wide a district as possible.

It was many years before a complete chronological table for Arizona could be built up, and in the interval the gradually accumulated data for the prehistoric timber from various excavated sites and derelict dwellings were built up into a "floating" table of relative dates. The position of this floating table in history could only be defined when sufficient links had been found to fill the gap beyond the oldest modern pine trees near Flagstaff, Arizona, which reached back to 1707. Many of these links were found in the roof beams from Hopi Indian dwellings, some of which are still in use with timber which has been felled several centuries ago. The last link connecting the floating table with this well-verified historical scale which stretched back to 1300 was finally provided by a buried and charred beam which was so fragile that it had to be well wrapped with twine before it could be lifted.

The coincidences between wood samples are more easily traced from small rings than from large ones, and the rings on each sample are charted on graph paper, giving an exaggerated upright line value for each small ring inversely proportional to its size (Fig. 1). A non-technical account of the work so far accomplished by Dr. Douglass and his helpers is given in "National Geographic Society Contributed Technical Papers; Pueblo Bonito Series, No. 1," Washington, 1935.

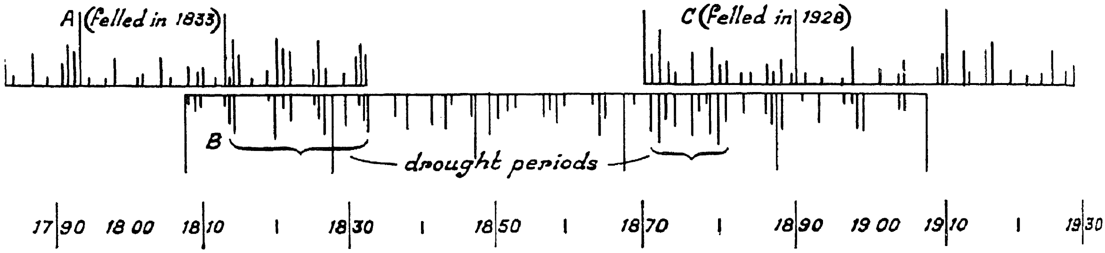

Fig. 1.
"Skeleton plots" showing small ring features of each timber specimen, and the process of matching characteristic groups of rings to build up a chronological table.

From a social aspect it is interesting to find that although the eclipse of the old Pueblo culture was in part due to a series of severe droughts, it was largely self-imposed through the wide-spread destruction of their upland pine forests by felling, burning, and heavy grazing. This was inevitably followed by excessive floods and droughts which rendered impossible their previous agricultural system of flood-water farming on the irrigable bottom lands along the outflows from these pine forest catchment areas. This corresponds roughly with what is happening to-day in many of the drier parts of the United States and the drier tropics of India and Africa, where the

natural vegetation has been destroyed by gross over-grazing and injudicious ploughing of natural grass-lands. In such places the contemporary local tree growth records will be found as a lengthening series of microscopic rings, just as in the period when the Pueblo culture was rapidly dying out. Dry spells may be inevitable, but their effects could largely be mitigated if we could, through a better knowledge of climatic cycles, foretell their arrival, and prepare for them through a more conservative use of the local resources of grass and timber. It is to be hoped, therefore, that some research may be taken up to show how far such data can be used to solve Indian problems in human and climatic history.

On the Structure and Function of the Ascidian Test.

By Dr. S. M. Das, D.Sc.,
Department of Zoology, Lucknow University.

THE present communication is intended primarily to supplement our knowledge of test of Tunicata, and secondarily to demonstrate that the test should not, as in the past, be regarded merely as an exoskeleton but should be considered as a medium for the communication of the animal with the outer world—comparable to the skin of the higher animals. The author's investigations were carried out on the test of the ascidian *Herdmania*, this animal being of a fairly large size and well represented in the coastal waters of South India.

The test of ascidians has been described by many authors in the past. Of recent years, Morgan[1] (1891) described the origin of the test cells; Herdman[2] (1899) gave a detailed account of the test in *Ascidia*; while Miss Herdman[3] (1924) worked out the histology of the test of *Botryllus*. None of these investigators, however, makes any mention of the presence of nerve-cells or of any nervous mechanism in the test. The author[4] has, however, demonstrated the presence of nerve-cells, nerve-fibres and receptor cells in the test of *Herdmania*.

The test, which except for the branchial and atrial apertures is the only part of the animal visible externally, surrounds the body of the ascidian and is about 4 to 6 mms. thick. At the postero-ventral end of the animal, however, the test is 2 to 3 cms. thick and constitutes a "foot" by which the animal remains attached to the sea-bottom. It is soft and leathery, more or less translucent and on sectioning cuts like soft cartilage. As in other ascidians it is composed of tunicine[5]—a close ally of cellulose. The general substance of the test consists of a clear matrix in which are present a large number of cells, interlacing fibrils, minute spicules and branching and anastomosing vascular tubes.

Test Vessels.—There are two main blood vessels, the *sub-endostylar test vessel* and the *sub-intestinal test vessel*, which enter the test and ramify into innumerable fine branches in its substance sending a few large branches into the "foot". These test vessels branch, anastomose and send fine branches towards the outer surface of the test where they end in ovoid or rounded terminal knobs or ampullæ (Fig. 1). The ampullæ appear red in colour due to the presence of red pigment in the ectodermal cells which cover them. These ampullæ appear very close to the outer surface of the test and thus bring blood into close contact with the oxygenated water in which the animal lives. They, therefore, form an apparatus for accessory respiration, which may be compared with the cutaneous respiration in other animals. The only other description of a respiratory organ besides the branchial sac (pharynx), in Tunicata, is that of Herdman[6] (1885).

The Spicules.—The spicules found in the test are of two types: the *microscleres*, which are very small in size, and the *megascleres*, which are much larger. They are all calcareous and have a definite shape

[1] Morgan, "Origin of test cells in ascidians", *Journ. Roy. Micr. Soc.*, 1891.

[2] Herdman, W. A., "L. M. B. C. Memoirs", I, *Ascidia.*

[3] Herdman, E. C., "L. M. B. C. Memoirs", XXVI, *Botryllus.*

[4] A detailed account of the investigations will be published elsewhere.

[5] Franchimont, "Sur la cellulose animale ou tunicine", *Compt. Rend. Acad. Sci.*, **89**, 755-56.

[6] Herdman, W. A., "On a new organ of respiration in the Tunicata", *Proc. Lit. Phil. Soc.*, 1885.

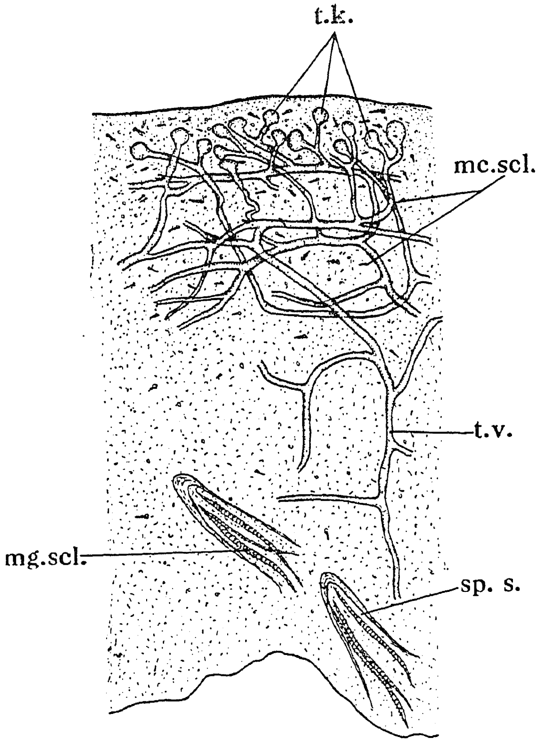

Fig. 1.

A vertical section of the test.—*mc. scl.*, microscleres; *mg. scl.*, megascleres; *sp. s.*, spicule sheath; *t.k.*, terminal knobs; *t.v.*, test vessel.

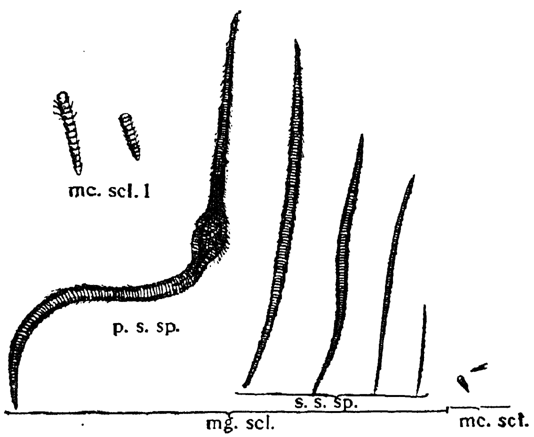

Fig. 2.

Spicules found in *Herdmania.*—*mc. scl.*, *mc. scl.* 1, microscleres; *mg.scl.*, megascleres; *p.s.sp.*, pipette-shaped spicules; *s.s.sp*, spindle-shaped spicules.

(Fig. 2). The microscleres are found in large numbers scattered throughout the test substance. Each spicule consists of a knob-like head and an elongated body bearing spines arranged in rings. Two kinds of megascleres have been found: the *spindle-shaped* and the *pipette-shaped* spicules. The spindle-shaped ones are enclosed in a connective tissue sheath and are present mostly in the postero-ventral half of the test, where they form a covering round the larger vessels traversing the test. As in the case of microscleres, each spicule has a large number of rings of spines. The pipette-shaped spicules are larger than the spindle-shaped variety and differ from them in having a swelling in the middle. They are, however, never found in the test, being confined mainly to the mantle. Herdman[7] (1885) gave a description of calcareous spicules in Tunicata and later[8] (1891) founded the genus *Rhabdocynthia* (*Herdmania*) on the presence of spicules. But he seems to have missed the pipette-shaped spicules altogether and has also made no mention of the exact structure, arrangement and distribution of the spicules.

Test Cells.—The *cells* of the test are of many different kinds. Five different kinds of cells can be discerned in *Herdmania* (Fig. 3) besides the nerve-cells and receptor

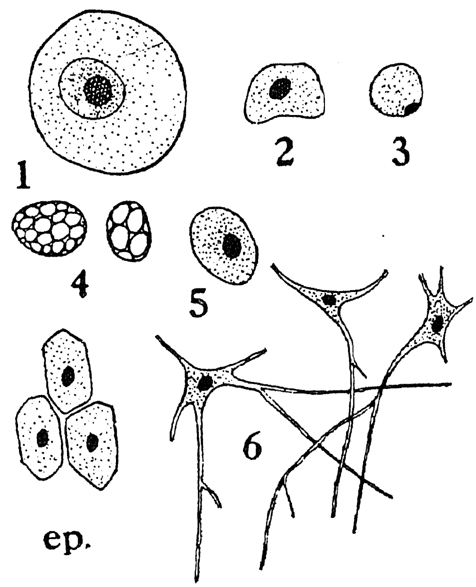

Fig. 3.

Cells found in the test.—1. Large eosinophilous cell; 2. Amœboid cell; 3. Small eosinophilous cell; 4. Vacuolated cells; 5. Granulated cell; 6. Nerve cell; *ep.*, epithelial cells from an ampulla.

cells described later. The largest of these are (1) the few *large eosinophilous cells*,

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[7] Herdman, W. A., "The presence of calcareous spicules in the Tunicata", *Proc. Liv. Geol. Soc.*, **5**, 1885.

[8] Herdman, W. A., "A revised classification of the Tunicata", *Journ. Linn. Soc. Zool.*, **23**, 575.

usually spherical in shape and staining a bright red with eosin. The cytoplasm consists of a thin homogeneous mass of fine granules and the nucleus is a large vesicular structure in the centre of the cell. Next to these in size are (2) the *amœboid cells*, which are few and far between. The most abundantly represented cells, however, are (3) the *small eosinophilous cells* each with an excentric nucleus. They are scattered throughout the substance of the test but are more abundant in the inner half of the test than the outer. Further, there are (4) the *spherical vacuolated cells*, each of which may consist of three to four chambers or may contain a large number of small vacuoles. A nucleus cannot be seen in these cells. Lastly, near the outer surface of the test are (5) a few *granular cells*[9] with large nuclei, around which the nerve-fibrils of the test get specially concentrated. The large bladder-cells present in the test of *Ascidia*[10] and some other ascidians are not represented in *Herdmania*, unless the small spherical vacuolated cells are to be regarded as remnants of them.

Nerve-cells and Nerve-fibres.—When an ascidian is kept in a tank containing fresh sea-water and the stimulus of contact applied to various parts of the external surface (test), the animal is seen to respond to the stimulus in a definite manner. On touching the siphons with a hard body they are seen to contract, usually closing the branchial and atrial apertures in this way. The rest of the test, however, is not so sensitive as the siphons. Nevertheless, a sharp pin-prick on the test of the body proper also causes an immediate contraction of the part stimulated followed by a general contraction of the siphons and the body proper. The idea naturally followed that nervous tissue should be present in the test to enable the animal to feel the prick. Quite thin sections of the test, properly stained, revealed on examination a large number of cells in the test substance which resemble very much the nerve-cells of the higher animals.

Each nerve-cell (Fig. 3, 6) is pyriform, triangular or polygonal in shape, contains a large nucleus and gives out two to six dendrites which get very much elongated, join similar processes from other nerve-cells and form a network of nerve-fibrils in the matrix of the test. The nerve-fibrils thus serve to connect the various nerve-cells with one another. The nerve-cells are more numerous in the test of the siphons than in that of the body proper and more so in the outer part of the test than in the inner. This is as it should be, if we take into account the greater sensitivity of the siphons and the fact that stimuli always affect the outer part of the test first.

Receptor Cells.—The external surface of the test of *Herdmania* can be divided into (1) the vascular areas, which have numerous vascular ampullæ, and (2) the non-vascular areas which have no ampullæ. Sections through the vascular areas of the test, when properly stained, revealed the presence of fine nerve-fibrils leading distally into the polygonal ectodermal cells surrounding an ampulla, usually a single nerve-fibre terminating in each cell (Fig. 4). Proximally, these nerve-fibres run on for some distance towards the base of the ampulla and then join to form a thicker nerve-fibril that runs on in the matrix of the test and is continued into the processes arising from the nerve-cells. It is quite clear, therefore, that in the vascular areas of the test, the epithelial cells surrounding the ampullæ form centres for the reception of stimuli. The nerve-fibrils communicate

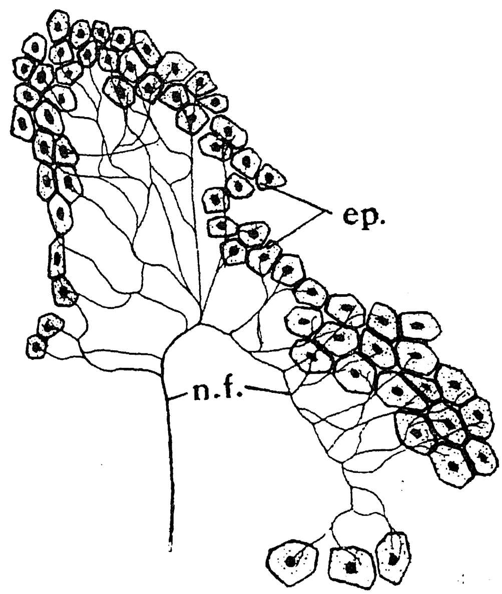


Fig. 4.

Nerve-fibres of an ampulla.—*ep.*, epithelial cells; *n.f.*, nerve-fibres.

[9] See account of receptor cells.

[10] Herdman, W. A., "L. M. B. C. Memoirs", I, *Ascidia.*

the stimuli to the nerve-cells. Experiments, however, showed that not only were the vascular areas of the test sensitive but that a pin-prick on the non-vascular areas of the test also produced similar effects though less marked in degree. Sections of the test through the non-vascular areas, revealed the presence of some ovoid cells, around which the nerve-fibrils of the test get specially concentrated. The presence of these cells in the non-vascular areas of the test, and their absence in the vascular areas, give additional proof that they have the same function here as that of the epithelial cells in the vascular areas.

Stimuli are, therefore, received by these receptor cells in the test and conducted by the nerve-fibrils which transmit them to the nerve-cells. Further, some nerve-fibrils from the nerve-cells pass into the mantle and finally join the nerves leading into the nerve-ganglion or brain. The instantaneous reaction to stimuli clearly shows that the nervous mechanism of the ascidian—though the nerve ganglion is said to be the degenerate representative of the larval brain and nerve-cord—is really very well developed.

Growth and Organisation of the Test.—The test in a living ascidian is continually worn at the surface. Growth takes place by the formation of tunicine by the ectodermal cells lining the inner surface of the test and also by the mesodermal cells which migrate into the test through the walls of the test vessels and the vascular ampullæ.[11] The new test always gets organised by the immigration of the various kinds of cells into it. The test as a whole, therefore, not only serves for the protection and attachment of the animal (facts mentioned in most text-books of Zoology) but also acts as a respiratory and a receptor organ.

Mention must be made here of the fact that this is the first time in the history of our knowledge of the Tunicata that a definite nervous mechanism has been demonstrated in the test or outer covering of these animals. The author wishes to express his thanks to Dr. Sundara Raj of the Madras Fisheries Department for placing the resources of the Tuticorin Fisheries Station at his disposal for the collection of material. Acknowledgments are also due to Prof. N. J. Berrill of Montreal and Prof. E. S. Goodrich of Oxford for their kind suggestions. To Prof. K. N. Bahl of Lucknow he is very much indebted for taking keen interest in the progress of the work.

[11] Herdman, W. A., "L. M. B. C. Memoirs," I, *Ascidia.*

Theoretical Biology.

To promote the study and work in the field of Theoretical Biology, a foundation for Theoretical Biology of animal and man, has been founded at the University of Leiden. In memory of the late Professor of Zoology, Van der Hoevèn (1801–1888), the author of the "Philosophia Zoologica," it is called "Professor Dr. Jean van der Hoeven Stichting von theoretische biologie van dier en mensch". The chief objects of the foundation are (1) to arrange for lectures at the University of Leiden, (2) to bring to Leiden, biologists who are interested in theoretical biology into contact with their colleagues in Holland and abroad, to bring about a contact for scientific purposes and organisations between theoretical biologists all over the world, for instance, by arranging international symposia on theoretical biology, (3) to publish articles on theoretical biology, and (4) to found a library on this subject. Directors of the foundation are Dr. C. J. van der Klaauw, Professor of General Zoology and Dr. T. A. T. Barges, Professor of Medical Anatomy, both at Leiden, and Dr. Adolf Meyer, Professor of Theoretical Biology at Hamburg.

Obituary.

Dr. Paul Brühl (1855—1935).

PROF. PAUL JOHANNES BRÜHL was born in Saxony on the 25th February 1855 and was the only surviving son of Michæl Brühl. He finished his early education in German schools and colleges and joined the botanical touring party obtaining the travelling scholarship, as was customary during those days. He walked all the way through Central Europe, Asia Minor and Armenia after halting for a short period at Constantinople where he worked as a teacher for some time. During his tour he made valuable botanical collections. He reached India in 1881 and joined the Rajshahi College in 1882 as a teacher of Natural Sciences. In 1883 he married Annie Betts Fox. His botanical interest was known at this time and the reputed Botanist Sir George King, the then Superintendent, Royal Botanic Garden, Calcutta, got him transferred to the Bengal Engineering College in 1887. Here Prof. Brühl taught various subjects such as Chemistry, Physics, Geology including Mineralogy, Heat Engines and Agriculture. His vast knowledge in many subjects and more than fourteen languages and art of teaching and laboratory methods were of a high standard which soon gained explicity all over this country. His popularity and sympathy towards his students and his keen interest in their welfare made Prof. Brühl's name a household word in many a Bengali house. His research work in Botany during his off time after the teaching work at the Engineering College found expression in such voluminous publications as *A Century of New and Rare Indian Plants* in collaboration with Sir George King. This work was published in the *Annals of the Royal Botanic Garden, Calcutta*, Vol. V, part II with 102–200 plates, most of which are Brühl's own sketches. His papers on "Plant Immigrants" is an important contribution towards the distribution of foreign plants in India. He officiated as the Principal of the Engineering College for some time. He retired from the Engineering College in 1912 and in recognition of his valuable and faithful service for forty years in the Government Educational Department, the title of Indian Service Order was conferred upon him by the Government of Bengal. After his retirement from the Government service his interest for research work did not abate. In 1912 from October to March, he worked in Chemical Geology in the Indian Institute of Science, Bangalore. He was for some time teacher in Geology and Mineralogy at the Presidency College, Calcutta, and officiating Patent Secretary to the Government of India. At the request of the late Sir Ashutosh Mukerjee, he accepted the post of the Registrar, Calcutta University, in 1913, and worked as a Registrar, Controller of Examinations and Secretary of the Arts and Science Department of the post-graduate classes which was just developing at this time. He had also to offer his valuable suggestions in building up the Post-Graduate Laboratories and was subsequently entrusted to build up the Biological Laboratory of the Calcutta University and was appointed the University Professor of Botany. His scientific investigation was recognised by the University in offering him Doctor of Sciences as *Honoris Causa*. As a University Professor he is one of the pioneers in the investigations of the Lower Cryptogams and in forming the present Indian Botanical Society of India. Here, as a teacher of the post-graduate classes in Botany again, he was able to contribute a large number of papers in Botany—his much beloved subject—in collaboration with his students. As president of a Committee appointed by the Government of Bengal, his research work, financed by the Government of Bengal, on the eradication of Water Hyacinth from 1925 onwards resulted in the publication of many papers which suggested various avenues of investigation on this vital question.

Among his many publications his latest contribution entitled "A Census of Indian Mosses" published in the *Records of the Botanical Survey of India*, Vol. VIII, 1930, and his book on "Sikkim Orchids" are of the greatest value to the botanical investigation in India.

He has left one son and three daughters and many successful students, friends, colleagues and admirers to mourn his loss.

K. BISWAS.

Letters to the Editor.

The Nature of the Transition from Troposphere to Stratosphere and Upper Air Temperatures over India in the Winter and Hot Seasons.

USUALLY in the tropics, the decrease of temperature with height which characterises the lower atmosphere, ceases suddenly at a height of 16–18 gkm. and a rise of temperature with height commences. In the winter and early hot season in N. India, below the above-mentioned inversion, there is often found another inversion or isothermal layer or layer of very small positive lapse-rate which may be more than 2 or 3 km. thick. Examples of such layers are shown in Fig. 1. The lower limit of this region may sometimes be as low as 10 gkm. in N. India. Dr. K. R. Ramanathan and Mr. K. P. Ramakrishnan in their paper on "Sounding Balloon Ascents at Poona and Hyderabad" explained this type of structure as being due to a meridional movement of air near the tropopause, the upper transition corresponding to the usual tropopause of tropical latitudes and the lower one to that of temperate latitudes. With a view to analyse the conditions of

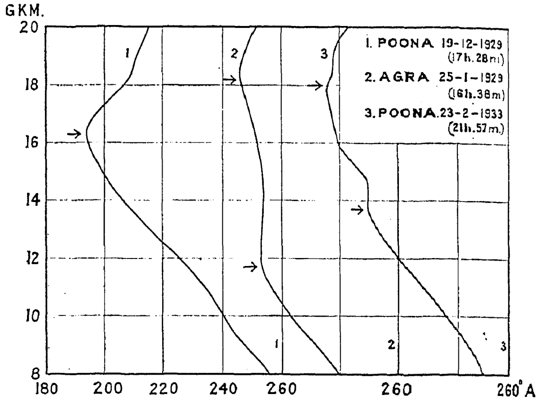


Fig. 1.

upper air temperature associated with this composite type of tropopause, the available sounding balloon data at Agra during the

TABLE I.

Number of occasions when the deviations of temperature from the mean of the month was between prescribed limits (Agra, 1925–1931).

A. When there was a first transition from troposphere to stratosphere at 10–12 gkm.
B. ,, ,, ,, ,, at 12–14 gkm.
C. When there was no sudden decrease of lapse-rate below 14 gkm.

ΔT °C / H gkm.	A						B						C					
	< −4	−4 to −2	−2 to 0	0 to 2	2 to 4	> 4	< −4	−4 to −2	−2 to 0	0 to 2	2 to 4	> 4	< −4	−4 to −2	−2 to 0	0 to 2	2 to 4	> 4
Ground	3	2	6	5	3	3	2	3	4	3	3	1	8	5	8	7	10	8
2	1	3	4	9	1	3	1	3	3	2	4	2	4	4	13	11	11	3
4	2	2	13	1	3	0	0	1	3	4	5	3	3	4	11	11	13	5
6	5	4	7	4	1	0	0	2	1	3	5	4	3	4	11	12	10	7
8	7	4	8	2	0	0	0	1	4	1	5	4	5	5	7	7	15	5
10	14	4	3	0	0	0	1	2	3	4	4	1	6	2	7	9	7	14
12	6	3	4	3	4	2	8	3	2	0	2	0	5	6	9	10	5	12
14	0	1	4	5	6	6	2	3	2	3	2	3	11	4	9	12	8	3
16	1	2	1	3	4	7	1	2	3	3	4	2	11	6	8	8	5	6
18	0	1	2	4	4	7	2	2	1	2	2	2	10	7	5	6	4	5
20	0	1	1	1	3	3	2	0	0	0	1	1	6	3	4	6	2	4

period November-March 1925–31 were arranged into three groups: (1) when a lower transition was present between 10 and 12 gkm., (2) when it was present between 12 and 14 gkm., and (3) when there was no evidence of such a transition below 14 gkm. Fig. 2 shows the average temperatures at different levels corresponding to each of

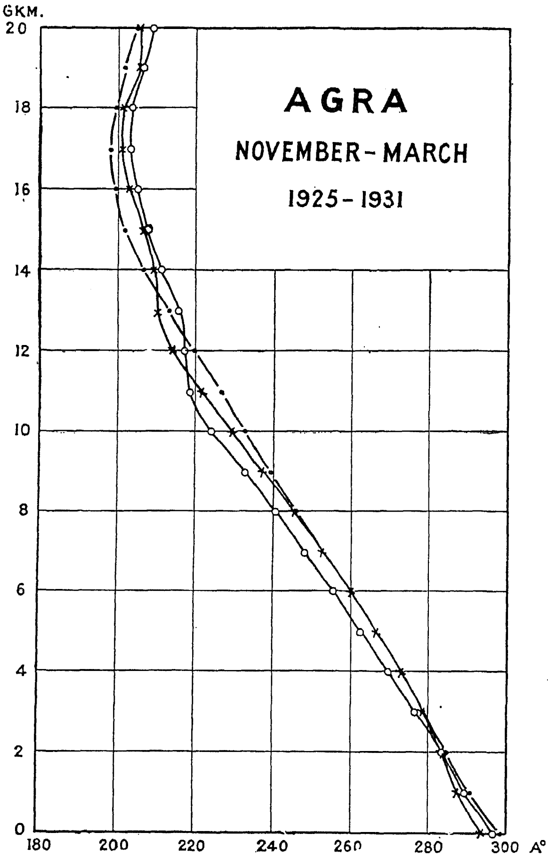


Fig. 2.

Mean Height Temperature Curves on days when a large decrease of lapse rate occurred.

(1) Between 10 & 12 gkm. O—O
(2) ,, 12 & 14 gkm. ×—×
(3) Above 14 gkm. ●—●

these three groups. It is clear from the figure that on the average, the presence of a lower transition is associated with abnormally cold air between 4 and 12 gkm. and abnormally warm air above 13 gkm. The occurrence of the tropical type of tropopause in this season goes on the average with higher temperatures upto 12 gkm. and lower temperatures above.

The frequency table (Table I) given above shows that while the presence of a lower transition is generally associated with abnormally low temperatures for 3–6 gkm. below that level, the converse proposition that extra low temperatures at say 8 to 12 gkm. are generally accompanied by a lower transition immediately above, is less certain.

As the upper inversion at 16–18 gkm. is present in more or less pronounced form on all occasions, we have to consider that it is due to some permanent cause—probably the presence of ozone. When meridional advection brings up air of lower latitudes to north India at these levels, the upper inversion may be expected to be more pronounced and conversely, when air from higher latitudes is brought over, the inversion will be less pronounced. Over Poona, the composite type of tropopause is less common, and when it occurs is less well-marked than

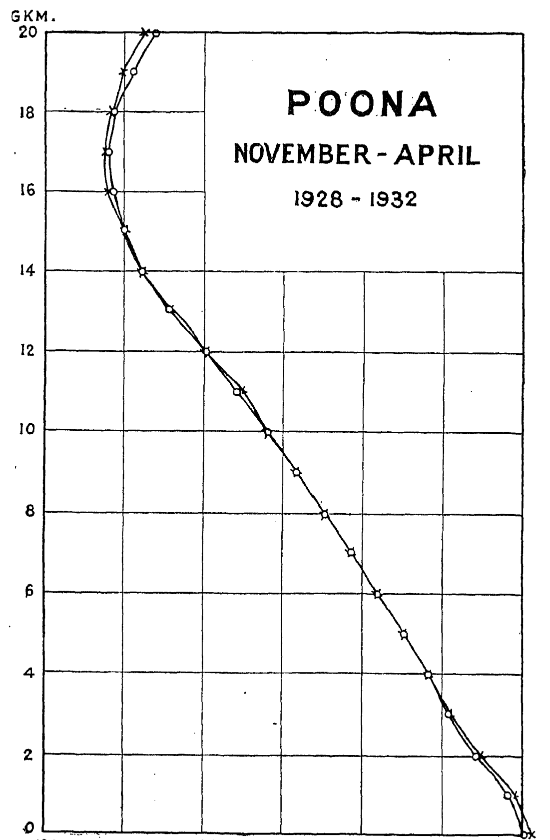


Fig. 3.

Mean Height Temperature Curves on days when a sudden decrease of lapse rate occurred.

(1) Between 13 & 15 gkm. O—O
(2) Above 15 gkm. ×—×

over Agra. It was therefore considered sufficient to analyse the Poona data into two groups: (1) when there was evidence of a lower transition between 13 and 15 gkm. and (2) when there was only one transition above 15 gkm.

Fig. 3 gives the average temperatures at different levels over Poona corresponding to each of these two groups. The difference between the two sets of averages is insignificant. Meridional advection can be expected to show the characteristic double transition best in those latitudes where the rate of change of height of tropopause with latitude is large. Agra lies in such a region in winter while Poona does not.

I am thankful to Dr. K. R. Ramanathan for suggesting this analysis.

Poona, M. W. CHIPLONKAR.
September 27, 1935.

Further Observations on the Diamagnetism of the Trivalent Bismuth Ion.

IN our note on the subject,[1] the value (43·80) for the diamagnetism of the trivalent bismuth ion was obtained by modifying the original Slater formula by assigning for electrons in the lower groups instead of shells and the *d* and *f* groups a value 0·85 instead of the usual 1. We have now calculated the value for Bi^{+3} by the orthodox Slater formula and its modification proposed by Angus and obtain the following results:—

		Experimental	Slater	Angus
$-x\times10^6$	Bi^{+3}	41·24	42·23	42·09

The agreement is as good as can be expected particularly on the Angus formula. More so when one realises that the Slater method is strictly valid for ions of the closed configuration type. Kido has brought out an interesting empirical relationship which seems to hold for a number of ions according to which the difference in the susceptibilities of ions due to two electrons is of the following order:—

	$-\Delta x\times10^6$
$P^{+3}-P^{+5}$	= 9·4
$As^{+3}-As^{+5}$	= 8·2
$S^{+4}-S^{+6}$	=10·4
$Se^{+4}-Se^{+6}$	= 9·5
$Cl^{+5}-Cl^{+7}$	=11·1
$I^{+5}-I^{+7}$	=12·5

The value for Bi^{+5} for which the Slater and Angus formulæ should strictly apply, has been calculated to be 29·22. The difference between Bi^{+5} and Bi^{+3} calculated on the Angus formula is 42·09—29·22=12·87, which is of the same order as suggested by Kido and is of particular significance.

It may be recalled here that out of the many compounds of bismuth mentioned in our last note, the susceptibility values of four are described in the *International Critical Tables* (Bi_2O_3, $BiCl_3$, $BiBr_3$, BiI_3). Three of these are in excellent accord with our values and only one has been shown to have a lower value.

Full results are being communicated to the *Journal of the Indian Chemical Society*.

S. S. BHATNAGAR.
BHIM SAIN BAHL.
University Chemical Laboratories,
Lahore.
October 5, 1935.

[1] *Curr. Sci.*, 1935, **4**, 153.

Some Aspects of the Mechanism of Non-Symbiotic Fixation of Atmospheric Nitrogen.

PREVIOUS studies on the economy of carbon during fixation of atmospheric nitrogen by Azotobacter, particularly by Stoklasa[1] and by Ranganathan and Norris[2] would suggest that the nitrogen fixers derive their organic nutrition chiefly from carbohydrates, though small quantities may be fixed in presence of other organic substances as well.

Our studies with the mixed flora of the soil showed that glucose which was provided as the organic nutrient was completely decomposed in the course of the first four days, being mostly converted into gases. Of the residual organic matter, 44·1 per cent. was accounted by micro-organisms (living as well as dead), 34·0 per cent. by organic acids (chiefly lactic, acetic, propionic and butyric) and the rest in some (yet unidentified) water soluble form. During this period only about a third of the usual quantity of nitrogen was fixed, and of this, the major part was present in water soluble form. In the course of the next four days a large part of the organic acids was lost, accompanied by corresponding increase in mucilage. There was also rapid fixation of atmospheric nitrogen, the C-N ratio of the organisms changing from 62·1 to 20·6. Between the 8th and the 12th days, there was very little change in the other constituents, but there was further fixation of nitrogen. After the 12th day, there was

slight loss of organic carbon, but there was no appreciable fixation of nitrogen.

TABLE I.
Distribution of Organic Carbon.

Time in days	Carbon in mg. (as present in 50 c.c. of medium)				
	Total organic carbon	Sugar	Organic acids (so far identified)	Microbial tissue	Unidentified
0	173·7	170·4	Nil	Nil	Nil
2	111·7	83·6	13·2	13·6	Nil
4	55·0	Nil	19·8	24·2	7·7
8	53·4	Nil	5·8	39·8	4·5
12	55·5(?)	Nil	4·8	39·9	7·5(?)
16	50·5	Nil	..	39·4	..

Carbonate carbon (including dissolved CO_2) was estimated at each stage, but has not been included. The soil used for inoculation contained 3.3 mg. of carbon.

TABLE II.
Nitrogen Fixed and C-N Ratio.

Time in days	Nitrogen fixed in milligrams in 50 c.c. medium		C/N	
	Total	In bacterial tissue	In the whole medium	In bacterial tissue
0	Nil	Nil	..	..
2	0·78	0·39	143·2	43·9
4	1·26	0·39	43·7	62·1
8	2·42	1·93	22·1	20·6
12	3·07	2·90	18·0	13·8
16	3·15	2·95	16·0	13·4

TABLE III.
Distribution of Organic Acids (so far identified).

Time in days	Organic acids in mg. of carbon (in 50 c.c. medium)					Total acids
	Non-volatile	Volatile				
	Lactic	Acetic	Propionic	Butyric	Total	
2	6·1	2·7	0·6	3·8	7·1	13·2
4	12·8	3·1	0·4	3·5	7·0	19·8
8	Nil	..	..	..	..	5·8
12	Nil	..	..	..	..	4·8

It would be seen from the above that (*a*) the carbohydrate contributes only partly to the fixation; (*b*) organic acids are mostly utilised for the growth of the organisms and fixation of nitrogen; and (*c*) the production of mucilage and nitrogen fixation, though related, are not directly proportional to each other.

That the immediate products of decomposition of sugar are utilised in the fixation is further proved by the following results (Table IV):—

TABLE IV.

Time in days	Nitrogen fixed in mg. (in 50 c.c. of medium)	
	Residue sterilised and freshly inoculated	Unsterilised (control)
4	0·25	2·10
8	1·62	2·62

Further work is in progress to determine (*a*) the manner in which organic acids or their calcium salts assist in fixation, and (*b*) the nature of the water-soluble nitrogen formed in the early stages and its relation to the subsequent fixation. The studies are also being extended to pure strains of nitrogen fixers.

T. R. BHASKARAN.
V. SUBRAHMANYAN.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
September 17, 1935.

[1] Stoklasa, *Zentralbl. Bakt. II*, 1908, **21**, 408.
[2] Ranganathan and Norris, *J. Indian Inst. Sci.*, 1927, **10A**, 79.

The Occurrence of Azotobacter at High Temperatures.

A GOOD deal of controversy has been going on for some time past, with regard to the action of light in tropical soils on such important soil phenomena as Nitrification, Nitrogen fixation, etc. Since Azotobacter and other Nitrogen-fixing organisms flourish the most between 25°C. and 30°C. and undergo encystment at higher temperatures, it is assumed by some investigators that when soil temperatures are higher than 30°C. in summer, no physiological activity can be expected from the Nitrogen-fixing organisms. It would perhaps be

worth while to test the correctness of the assumption by actual examination of the soils which have attained higher temperatures in summer for the presence of Azotobacter and other Nitrogen-fixing organisms. We have endeavoured to find information on this point by examining a few soil samples taken in June last when typical summer conditions were prevailing.

The following table would show the atmospheric temperature, soil temperatures and moisture contents of the soils:—

Soil Used	Atmospheric Temperature. °C.	Soil Temperature °C.	Moisture Contents %
1. Cultivated soil with low Moisture Content ..	49	44	8·6
2. Cultivated soil with high Moisture Content ..	,,	42	21·1
3. Garden Soil	,,	42·5	19·5
4. Grass Soil	,,	45	0·36

Samples of soils mentioned above were divided into two portions of equal weights, one lot of each soil was heated upto 80° C. for ten minutes so as to kill all the vegetative forms, and the other lots were left unheated.

A small quantity from each of these eight soil samples, *viz.*, four heated ones and other four un-heated ones, were inoculated in the liquid Ashby's mannite medium. After a few days' incubation at room temperature the pellicle was observed in all the unheated soils, while no pellicle could be seen in the heated samples. Dilutions were also made from each flask and each dilution after addition to Ashby's mannite Agar was plated out in sterilized Petri dishes. In a few days' time the Azotobacter colonies appeared along with some other bacteria in the plates of the unheated soils. In the plates of heated soils, however, other types of bacteria appeared while Azotobacter colonies were very few or none at all in number. Pure cultures were made from Azotobacter and other bacterial colonies appearing on the plates and are kept for further work.

It is not possible at this stage to write definitely regarding the species of Azotobacter which have been observed at such high temperatures in all the samples stated above, but the view held by some investigators that photo-fixation of Nitrogen is the only process of Nitrogen-fixation prevailing at temperatures higher than 30° C. can no longer be maintained, because it has been amply proved that Azotobacter cells are present in the vegetative state in the soil at temperatures as high as 45° C.

This is probably an instance of the frequently observed phenomenon of the adaptation of living organisms to their environments.

Jagjiwan Singh.
Ahmad Hussain.

Botany Department,
Government College, Lahore.
August 14, 1935.

Pungency in Chillies (*Capsicum annum*) A Mendelian Character.

Chillies (Red pepper) is one of the important agricultural crops of South India and it is grown mainly for the pungent fruit which is an indispensable item in the dietary of Indians. There are ever so many varieties differing in size, shape, colour and pungency of the fruits. While the varieties grown as field crops are all highly pungent, those grown on a smaller scale and used mainly as a vegetable are not so. The pungent varieties are generally small fruited and contain a large amount of seed while the non-pungent ones are big fruited, more fleshy and contain less of seed. Evidently the evolution of the big-fruited varieties has taken place with the loss of pungency. The variety (*Capsicum frutescens*) which still grows wild in several parts of the Presidency has extremely small fruits and is the most pungent of the group.

The inheritance of a large number of characters in chillies has been studied by Deshpande[1] (1933) but we have not come across any reference to the inheritance of pungency. It has therefore been considered that the information given below with regard to this character will be of interest.

We have been growing recently a large number of chilly varieties at the Paddy Breeding Station, Coimbatore and we have also made some crosses amongst them. One of these crosses was between a variety 'Elephants-trunk'—a long big fruit without any pungency and another small-fruited variety but extremely pungent. The F_1 was found to be pungent and a portion of the F_2 has been raised recently. Due to the unfavourable season, several of the plants had

succumbed to wilt and thrips after transplanting, leaving only 25, which matured and bore fruits. The fruits of these plants were examined individually and it was found that 18 bore pungent fruits while 7 were definitely non-pungent. The non-pungent fruits were easily distinguishable from the pungent though there was a good bit of variation in the latter.

The active principle in chillies which accounts for the pungency is an organic compound with a definite constitution and it is possible, its presence or absence may be tested chemically, but so far as our examination recorded here is concerned, we classified the plants by actually tasting the fruits of each plant. Some more of these F_2's have since been grown and in addition to pungency, other characters like size and shape and the amount of seed present and their association with the pungency character are under study. The results will be published separately.

K. RAMIAH.
M. RAYAPPA PILLAI.
Agricultural Research Institute,
Coimbatore,
October, 1935.

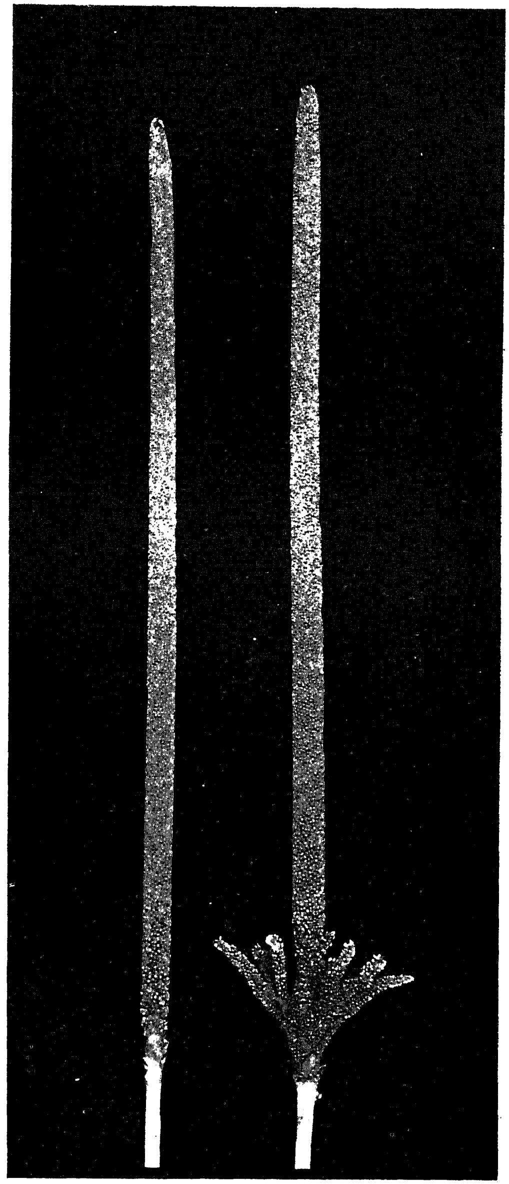
[1] Deshpande, *The Ind. Jour. Agri. Sci*, 1933, **3**, 219-300.

Basal Branching in the Earheads of the Pearl Millet—*Pennisetum typhoides*, Stapf and Hubbard.

THE inflorescence of the Pearl (Spiked) Millet is its characteristic rod-like false spike. Round a central axis are clustered together a number of fascicles having short pedicelled flowers. The hermaphrodite and antheriferous flowers together with the bristle brush constitute the fascicle. This rod-like disposition eminently meets the necessities for the fertilisation of this protogynous, lodiculeless millet with its delicate stigmas.

As recorded by Bews,[1] starting from the spreading type of panicle the main evolutionary trend in grasses has been "towards contraction, condensation, reduction and as a result increased protection". The protogyny and absence of lodicules impose additional needs for this protection in this millet.

Stapf in his description of the Pennisetums of Tropical Africa[2] mentions the occasional occurrence in some specimens from Nigeria of an abnormality in which "many of the lower and intermediate fascicles are replaced by slender spike-like branches up to 8 inches long". Such an abnormality has been experienced at Coimbatore in the case of an odd plant from a variety of the Bellary district.



In the year 1934 in some Sorghum seed imported from Nigeria, there was an odd seed of pearl millet which gave rise to an earhead whose unusual length attracted attention. The basal portion of this earhead was normal and unbranched. The

seeds from this odd plant were sown and a crop raised. In this population a clear segregation between entire and branched bases was noticed. Counts were taken and gave 342 unbranched and 127 branched bases (*vide* illustration). The segregation was sharp.

The branching occurred over an area of two inches at the base. An analysis of this area together with a corresponding two inches of the normal unbranched area gave the following figures:—

	Unbranched area	Branched area
Number of branches ..	..	28
,, fascicles ..	142	1,446
,, grains	437	1,431
,, grains in a 2 gm. weight ..	135	263
Weight of grains (gm.) ..	6·39	10·95
,, chaff (gm.) ..	·96	2·95

The above table clearly reveals the economic disabilities of this branched atavistic condition which has proved a simple recessive to the normal rod-like inflorescence of this millet.

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P. V. HARIHARAN.
S. R. RAMAKRISHNAN.
Millets Breeding Station,
Coimbatore.
October 1, 1935.

[1] *The World's Grasses*, 1929, p. 18.
[2] *Fl. Trop. Afr.*, 9-6, p. 1046.

Peucedanum graveolens—A New Host of Powdery Mildews.

DURING the last winter season a local variety of *Peucedanum graveolens* commonly known as soâ—a herbaceous plant used in curries and cultivated for its seeds and leaves—was found to be attacked by powdery mildews. Subsequent observations indicated that the first sign of the disease is found in the appearance of small white specks on the lower filiform leaves. The infected spots enlarge, coalesce and gradually cover the entire assimilating surface. With advance in season, the fungus spreads from leaves to the stem and finally infects the inflorescence. In severe cases the attack is damaging and the seeds fail to mature properly.

The usual organism appears to be similar to what has been described by Uppal and Desai on *Cuminum Cyminum*.[1]

Detailed investigation is, however, in progress and will be reported subsequently.

B. N. SINGH.
S. C. CHAKRAVARTI.
Institute of Agricultural Research,
Benares Hindu University,
September 28, 1935.

[1] "Cumin Powdery Mildew", *Dept. of Agriculture*, Bombay, *Bull.* No. 169, 1932.

The Method of Selecting a Representative Sample in Social Research.

By P. V. Sukhatme,
Department of Applied Statistics, University College, London, W.C.1.

IN Social Research, it is often required to estimate the average value of a character of some individuals. Such averages may be calculated whenever possible from the data supplied by the decennial census in India. These data do not, however, always provide the necessary material required for all types of population research and it is, therefore, imperative that fresh inquiries should be undertaken from time to time to collect the material.

It is, however, obvious that an *exhaustive* inquiry cannot be undertaken every time for want of both time and money. Nor is it necessary for the attainment of sufficiently accurate results. It is therefore advisable to base the results on the data supplied by the process of sampling. This process has been termed the 'Representative Method'.

It has been shown by Dr. J. Neyman that the most general aspect of the representative method is that of random stratified sampling of groups.[1] The method consists in dividing the population studied into parts called 'strata' and in sampling randomly from separate strata. The number of sampling elements to be chosen from each stratum may be determined by any one of the following methods :—

(1) The method of proportional sampling suggested by Professor A. L. Bowley.[2]

[1] J. Neyman, *Jour. Roy. Stat. Soc.*, **97**.
[2] A. L. Bowley, *Bull. Int. Stat. Inst.*, **22**.

(2) The method suggested by Dr. J. Neyman.[1]

The first method consists in choosing a number of elements from each stratum proportional to the total number of elements M_i in that stratum. The second consists in choosing a number from each stratum proportional to the product $M_i \sigma_i$ for that stratum. (σ_i^2 denotes the variance of the elements of the ith stratum about the mean of that stratum.) If σ_i^2 has different values in different strata, as is invariably the case, the second method is known to be more accurate than the first.

In general we do not know the values of σ_i. They can, however, always be estimated by means of a preliminary inquiry. It has been shown that if the σ_i's are estimated from sufficiently large samples (each of the order of 20 elements), then Dr. Neyman's method will almost invariably lead to more accurate results. Further it has been found that if the variability of the character sought within the single strata is very different in different strata, the gain in accuracy is of considerable magnitude.

The question of expense connected with the preliminary inquiry has also been considered and it has been found that in most cases Dr. Neyman's method is still advisable and may not prove too expensive.

The details will be found in the forthcoming issue of the Supplement to the *Journal of the Royal Statistical Society*, London.

Occurrence of Lime in Edible Momordica.

By H. L. Chakravarty, M.Sc.,

Herbarium, Royal Botanic Garden, Calcutta.

ABUNDANT deposit of lime in the form of crystals or cystoliths have been observed in the body cells of our common "Uchhya or Corola" (*Momordica charantia* Linn.) and Kakrol (*Momordica cochinchinensis* Spreng). Lime as calcium carbonate occurs in the form of cystoliths in leaves and as calcium oxalate it occurs as crystals mostly in stems and petioles. Portions of the cuticular membrane of the under-surface of the leaves of the two species when seen under the high power of a microscope, groups of globular deposit of calcium carbonate over a cellulose skeleton are visible. Such an aggregation of globular deposit of lime is defined as cystolith. These cystoliths are frequently present in the lower epidermal cells of the leaves and due to deposits of large quantities of calcium carbonate the epidermal cells grow considerably in size. Sometimes they are as large as ten times that of the size of an ordinary epidermal cell. These inflated cells containing cystoliths are gradually pushed into a considerable depth of the mesophyllous tissue and hence in a transverse section they seem to arise from the spongy tissue of the mesophyll.

The presence of the cystoliths of *Momordica charantia* was first observed by an Italian scientist, Dr. Otto Penzig,[1] in 1881. He determined also the nature of the structures of the cystoliths. Zimmermann[2] in his recent monograph on Cucurbitaceæ has described a few European and African Momordica. It appears that no contributions have yet been made towards the anatomical nature of the leaf-cells containing cystoliths of Indian species of Momordica. I have therefore made an attempt towards this direction. A group of cystoliths is the separate deposit of lime in various fantastic aggregations on a central skeleton. Cystoliths generally occur in groups of 2–7. In Fig. 1(A), Plate I, we find a cystolith of triple group as is found in *M. charantia*. In this species cystoliths occur also in groups of 2–4. Sometimes cystoliths are present in as many groups as seven (see Fig. 2(A), Plate I). Such groups of seven are seldom met with. In the process of the growth of cystolith calcium carbonate is strongly impregnated over a cellulose skeleton and when the deposit of calcium carbonate is dissolved in dilute HCl a skeleton of cellulose with concentric stratification makes its appearance. The cystoliths of *M. charantia* are more or less of definite regular oval-shaped structures and are non-branched and monoplanous.

The cystolith of *M. cochinchinensis* appears to have not yet been reported by any previous worker (see Figs. 3, 4). They are mostly irregular in structure, branched and

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[1] Penzig, *Verbreit d. cystolith etc.*, *Bot. zentralbt*, 1881, **8**, 393-403 and Tables II-IV.

[2] Zimmermann, *Die. Cucurbitaceen*, Jena Verlag Gustav, Fischer, 1922.

heteroplanous. In the beginning of the formation of cystoliths in this species the cystoliths do not show much difference from those of *M. charantia* but as they grow up they branch off and ultimately show the characteristic structure as shown in the figure. Here also as in the previous species,

(*Continued on p.* 261.)

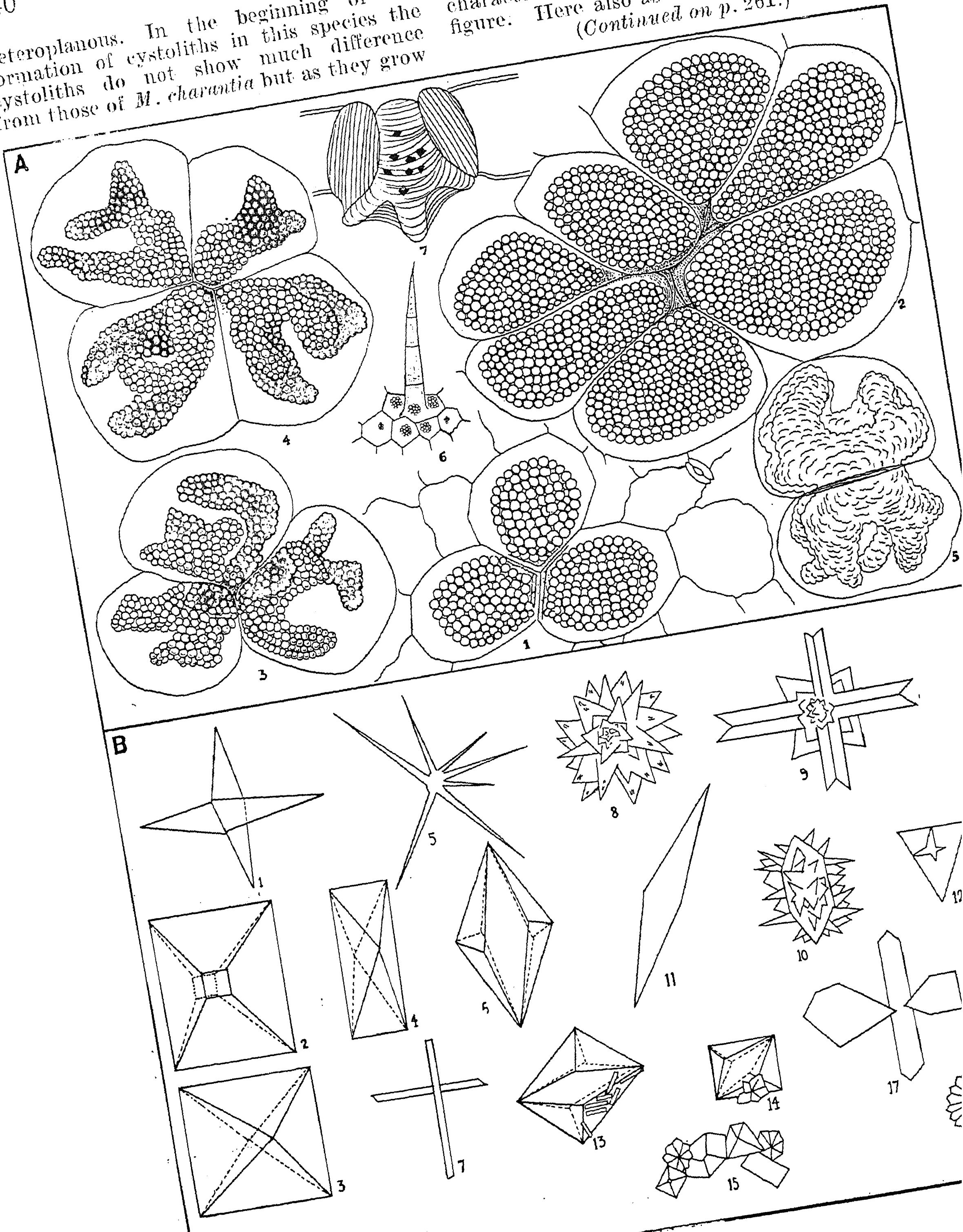


PLATE I.

SUPPLEMENT TO "CURRENT SCIENCE".

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Norwich, 1935.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS.

Mathematical and Physical Sciences.

President: DR. F. W. ASTON, SC.D., D.SC., LL.D., F.I.C., F.R.S.

THE STORY OF ISOTOPES.

A HISTORIC account of Isotopes has to begin with Prout's speculative suggestion that all atoms are made up of the particles of some primordial substance. It follows as the result of this hypothesis that the atomic weight of an element must be expressed in whole numbers. It was soon found by chemists that this was not the case and the hypothesis was thus abandoned.

The next landmark in the progress of the idea of Isotopes is to be found in the remarkable statement of Crookes in his Presidential Address, Section B, at Birmingham in 1886, "I conceive, therefore," he said, "that when we say the atomic weight of, for instance, calcium is 40, we really express the fact that, while the majority of calcium atoms have an actual atomic weight of 40, there are not a few which are represented by 39 or 41, a less number by 38 or 42, and so on". These hypothetical components, he called 'meta-elements', but this suggestion of Crookes did not bear any fruit.

The discovery of radio-active phenomena in which the attention of the experimentalist is focussed on the behaviour of individual atoms, led the way to the discovery of elements with identical chemical properties but different atomic weights. The first definite indication of the existence of such elements is to be traced to the discovery by Boltwood in 1906 that ionium and thorium, when mixed together, could by no known chemical process be separated from each other. The radio-active law that when a radio-active element loses an α-particle, it goes back two places in the periodic table and by the loss of a β-particle, it goes forward by one place, may be taken as the first definite formulation of the nature of Isotopes.

Soddy was the first to call two elements having identical chemical properties and difficult of separation when mixed, Isotopes or Isotopic elements, because they occupy the same place in the periodic table. Uranium lead which results from uranium of atomic weight 238 by the loss of eight α-particles has an atomic weight of 206 and thorium lead which results from a loss of six α-particles from a thorium atom has an atomic weight of 208. Soddy put forward the view that the atomic weight of the lead found in uranium minerals must be less and that of the lead found in thorium minerals, more than the atomic weight of ordinary lead, *viz.*, 207·2. In modern nomenclature, it is generally accepted that Isotopes are elementary substances having the same atomic number but different atomic weights. We know now that most of the chemical and physical properties of the isotopes of any element are identical.

Dr. Aston points out that orthodox science was very reluctant at the beginning to accept the view that elements with different atomic weights could have identical chemical properties and he says, "This reluctance of orthodox science to accept the theory was, I think, a perfectly natural and healthy reaction. Criticism very seldom destroys enthusiasm and is usually the best stimulant to further research."

The next advancement in the experimental study of isotopes was the 'parabola' method of positive ray analysis started by Sir J. J. Thomson. These investigations of Sir J. J. Thomson led to the discovery of the two Isotopes of Neon of masses 20 and 22. Aston points out that in these investigations he was associated with Sir J. J. Thomson and as a result of this association, he, after a series of difficult diffusion experiments, was able to show that Neon was not homogeneous by getting two samples of Neon which differed in density by about 0·7 per cent.

It is undoubtedly the mass spectrograph of Aston that placed the existence of Isotopes beyond any possibility of doubt. With the aid of the mass spectrograph, Aston showed that Neon consisted of atoms of mass 20

and 22 in relative abundance of 9 to 1, so that we get the mean atomic weight 20·2. Chlorine, bromine, krypton, xenon and others were analysed and found to be mixtures of Isotopes of different masses. It was established that the "whole number rule" indicated that atomic nuclei were built up of the units, protons and electrons, in appropriate relative numbers to give the atomic number. Dempster at Chicago, with a mass spectrograph of his own design, made Isotopic analysis of magnesium, calcium and zinc.

The two main methods of obtaining the necessary rays for analysis are (1) the ordinary gas discharge which requires that the element under examination should be volatile or should form suitable volatile compounds and (2) the anode ray discharge in which the compound of the element is the anode in a low pressure discharge. In this connection says Aston with truth that "Our knowledge of the mechanism of the discharge in both methods is far from complete, so that working with them is still rather an art than a science. The element of luck has played an important part in cases where the properties of the materials are unfamiliar and unfavourable to the conditions of the discharge."

The four elements, palladium, iridium, platinum and gold, remained without mass spectrograph data. Recently, however, Dempster has analysed platinum and finds five Isotopes. Gold, he says, is single. It is found that no element of odd atomic number has more than two Isotopes. In the case of even elements, *i.e.*, elements with even atomic numbers, the finding is different; tin, for instance, having as many as eleven Isotopes ranging from 112 to 124 in mass numbers. It is also found that up-to the number 210, a stable elementary element atom is known for every number, and often there are 'Isobares,' that is, there are elements with the same atomic weight but different atomic numbers.

Next Aston discusses the technique of the determination of the relative abundance of the Isotopes of an element. The question of 'packing fractions' and the contribution of Bainbridge to the study of Isotopes are discussed. Then in an account of the sensational discovery of the now well-known Deuterium, the heavy Isotope of hydrogen with mass number 2, of the Isotopes of oxygen 17 and 18 and other relevant questions, are taken up for consideration.

"In the field of Isotopes," says Aston at the close of the address, "as in so many fields of physical and chemical research to-day, the objective we now aim at is the next decimal place, an elusive object which always appears to be running away from the observer, like a distant spiral nebula..... In artificial radio-activity and transmutation we see the real beginnings of a great new subject, the nuclear chemistry of the future....... Armed with reliable equations, and thereby with more and more definite knowledge of nuclear construction, he (the chemist) will transmute and synthesise atoms as his elder brother has done molecules, with results to be wondered at and possibly even misused by his fellow creatures. I foresee a time, not immeasurably far distant, when it will be possible for us to synthesise any element whatever, whenever and wherever we please; alchemy indeed in the service of man."

Chemistry.

President : PROF. W. N. HAWORTH, F.R.S.

THE MOLECULAR STRUCTURE OF CARBOHYDRATES.

PROFESSOR W. N. HAWORTH'S address is a welcome synopsis of current views on the architecture of carbohydrates, the class comprising sugars and the various forms of starch, cellulose and vegetable gum. To their economic and alimentary importance must be added their significance in the development of organic chemistry, throughout whose course the attraction of their changes and the repulsion of their properties have afforded its practitioners a constant allurement. They are so closely interwoven in the fabric of this development that organic chemistry without the carbohydrates would seem as unsymmetrical as the Taj Mahal with only three principal minarets.

Since the death of Emil Fischer a substantial change in the structural presentation of sugars has been consolidated. Fischer's most notable activities in this field were directed towards elucidation of configurational problems, and although he did not exclude the possibility of a cyclic structure, in fact adopting it for the glucosides, common practice continued to represent the parent sugars by hydroxylated carbon-chains including an aldehyde-group (the aldoses), or a keto-group (the ketoses). It is these groups that lead to the glucosidic, or the oxide, ring. Haworth (1925) presented a structural

model of glucose in the form of a six-atom cycloid, and the supporting experimental evidence now accumulated is formidable.

By the new (amylene oxide) presentation, normal glucose and fructose are derivatives of tetrahydropyran, and are therefore denominated pyranoses, while the γ-isomerides are recognised as derivatives of tetrahydrofuran, and are classified as furanoses. This redisposition has been made without requiring to disturb the configuration of hydrogen atoms and hydroxyl groups previously distinguishing the hexoses, which are now identified by names recalling both origin and structure, *e.g.*, glucopyranose, mannopyranose, glucofuranose, fructofuranose, etc. From this groundwork, disaccharide-formation follows the two-fold course revealed by the properties of the products, namely, those (*a*) which retain a potentially free carbonyl group, *e.g.*, maltose, lactose, cellobiose, and (*b*) which have lost this feature, *e.g.*, sucrose, trehalose ; and it is now possible to identify the carbon atoms of each combining pyranose or furanose which is concerned in the union. For example, maltose-formation involves carbon atoms 1 and 4 of the two combining glucopyranose molecules, while sucrose arises by uniting carbon atom 1 of glucopyranose with carbon atom 1 of fructofuranose. This type of diagnosis has latterly been greatly extended, penetrating the obscurities of the polysaccharides inulin, cellulose, starch and xylan (wood gum).

The majestic edifice of carbohydrate chemistry now rising on the foundation so truly laid by Fischer, and to which Haworth and his collaborators have contributed very substantially, could not have reached its present ample proportions without the device of methylation, introduced by Purdie and Irvine (1903), and with suitable modification since applied to di- and polysaccharides. Crystalline tetramethylglucose heralded a long series of polymethylsaccharides whose physical properties are more helpful than those of the parent hydroxy-compounds ; they are easily crystallisable from organic solvents, show definite melting points, and in some cases may be distilled under greatly reduced pressure. It was from a study of tetramethylglucose and of its methylglucoside that the pyranose-form in hexoses and pentoses came to be verified ; and the survival of polymethylated hexose-units from careful hydrolysis of polymethylated di- and polysaccharides has vividly illuminated the structure of these elusively complicated materials. The address under review portrays in striking manner the combination of cellobiose-units in a continuous chain to form cellulose, and compares the latter with starch, correspondingly formed by combination of maltose-units.

The picture thus presented harmonises with the results of X-ray analysis, and a chemical estimation of the cellulose chain-length has indicated 200 glucose-units as the most probable approximation. Some explanation must therefore be given to account for the wide incongruity between this molecular weight and that indicated by physical methods, and in Haworth's view this is owing to natural cellulose consisting of aggregated chemical units, associated perhaps by co-ordinated co-valencies, catamaran-wise. Many of the changes incurred by cellulose in the laboratory and in industrial processes involve a disaggregation of the physical unit preceding chemical transformation into derivatives.

Elucidation of the starch-complex reveals corresponding general features. Methylated starches from three sources are uniform in the chain-length of their chemical unit indicating a combination of 25 glucose-units, while the physical method of molecular weight determination manifests a far higher value. As in the case of cellulose, this discrepancy may be explained by aggregation of chemical units, because, by a simple method, Haworth has prepared a disaggregated starch which, in the form of its acetyl and methylated derivatives, has the same molecular weight as determined alike by viscosity and by gravimetric assay of the terminal group. This disaggregated starch is not degraded, but is probably the chemical unit, capable of undergoing re-aggregation to physical assemblages of increasing viscosity. Glycogen specimens, on the other hand, with chain-lengths of 12 or 18 glucose-units, display little or no tendency to molecular aggregation.

The polysaccharides levan (from grass-leaves) and inulin, analogous condensation products from fructofuranose, are reviewed in the address, and lichenin (from lichen cell-walls) is shown to resemble cellulose in structure with a considerably shorter chain-length of about 80 glucose-units. Xylan (from esparto) has 18 or 19 xylopyranose-units terminated by an arabofuranose which can be removed intact, when the residual chain comprises only xylopyranose-groups. At least one method by which Nature effects

the synthesis of these complex molecules is indicated by reference to the constructive action of micro-organisms on solutions of glucose and other sugars, when the resultant polysaccharides are found to contain hexose-units in which, very surprisingly, the glucose-configuration has been changed. Finally, it is anticipated that advances in medical knowledge will arise from polysaccharides having immunological function, which are not simple in structure, and probably have a molecular weight exceeding 2,000.

It is unusual to find in the lay press a pertinent inquiry relating to carbohydrates but Dr. A. S. Russell, writing in *The Listener* (August 28, p. 361), asks why the *d*-glucose-configuration holds a unique place among the sugars. When there are sixteen possible distributions of hydroxyl groups and hydrogen atoms why, he asks, should the dice be loaded so heavily in favour of *d*-glucose ? It seems to suggest that Nature is not a communist. The question is well worth asking, and perhaps Professor Haworth will one day be able to answer it.

Geology.

President: PROFESSOR H. G. A. HICKLING.

SOME GEOLOGICAL ASPECTS OF RECENT RESEARCH ON COAL.

THE conception that coal is a metamorphic rock is ancient but evidence to establish this has been obtained only by recent researches. In the eighteenth century knowledge about coal was confined to the conditions under which coal had been formed—the *in situ* and drift theories of origin of coal—but little was known as to the nature and general mass of the rock itself. There was uncertainty, as to whether the major differences in coal were determined during the accumulation of the deposit, by the kind of plant materials and by their state of decay or whether the chief factor was the effect of physical forces brought to bear on the deposit after its burial in the crust. The recent researches of palæobotanists and fuel technologists have clarified these points to a considerable degree.

The uncertainty regarding the structure of the coal in earlier days was due to the difficulty of preparing thin slices for microscopic examination. Henry Witham in 1833 prepared sections of coal and from their studies William Hutton concluded that every variety of coal is of vegetable origin and the difference of the nature of these varieties has most probably arisen from an original difference in the nature of the vegetables of which they were composed. During the greater part of the eighteenth century progress in the study of coals was slow, though bleaching and macerating agents were used to elucidate the plant structures. The modern period of coal petrology is the offspring of the palæobotanical research of the nineteenth century and this work has given a precise knowledge of the structure of the plants which formed the coals and a clear picture of the condition of some of the coal peats at the time of their deposition. During this period the technique of microscopic examination and section cutting advanced rapidly due to the researches of Jeffreys Theissen, Lomax, Winter and Seyler.

Before the time of Witham and Hutton coal was regarded as a deposit from solution —a kind of vegetable extract, but microscopic examination limited this idea by revealing the abundance of organised plant structure in coals and the abundant presence of the characteristic " uniform brown substance "— the " lignitoid material " of Jeffreys or the " anthroxylon" of Theissen. Stopes classified the types of coal substance seen in bituminous coals and gave an account of their constitution as revealed by the microscope, and emphasised the laminated character of coal. Later researches have shown the abundance of plant structures in " coal substance " and that coal is a characteristic mixture of this " coal substance " and other ingredients. However the " uniform brown substance" could not still be resolved entirely and at present there are two views regarding the nature of this material. Some contend that it is entirely made up of plant fragments, while others suggest that a large part of the substance decayed to the condition of a true fluid which solidified as a structureless gel which acted as cement to the whole mass. Two distinctive features of this substance are the low ash content and little variation in its organic composition as compared with other constituents of coal. This substance may be called " Vitrinite ".

The other components of coal, though subordinate in quantity to vitrinite, determine largely by their varying quantities different varieties of coals. Chief among these is fusain or " mineral charcoal " formed from woody tissue and characterised by low hydrogen and oxygen content. The next group of coal components may be designated the " high hydrogen group ",

the outer coatings of stems, leaves and spores, which are characterised by an accumulation of waxes, fats and resins. Their presence alters the composition of coal specially in hydrogen content. There is still another ingredient of coal characterised by its minute state of fragmentation a sort of residuum to which Stopes has given the name—micronite. The cannels and boghead coals have different structures and have the distinctive presence of microscopic oil-bearing algæ—essentially similar to the living oil alga—*Botryococcus braunni.* The presence of this constituent has the striking effect of increasing the hydrogen content of these coals.

An examination of the types of coal aggregate shows variations in the quantity of coal components which possess different grain sizes. As the average size of the particles in any coal aggregate decreases, the proportion of vitrinite lessens while there is a corresponding increase of the "high hydrogen group" and the micronite, thus determining the exact quality of coal. Differences in coal have resulted not only by the type of aggregate but also by the degree of alteration (the rank of the coal) to which the original composition of the aggregate was subjected. There is considerable divergence of opinion in assessing the relative importance of these variable factors in determining the differences in the quality of coal. Chemically considered coal components consist mostly of carbon, hydrogen and oxygen,–these being marked variations in their hydrogen content. Representative analysis of bituminous coals shows the following limiting variations, hydrogen 4·5 to 6, carbon 65 to 90 and oxygen 5 to 30%. The variation in hydrogen content of these coals is largely determined by the character of the original materials but the carbon: oxygen ratio is determined solely by other considerations. It is this difference of oxygen content which denotes the rank of coal distinguishing the lignites, bituminous coals and anthracites.

Thus we see that the rank of a coal is the measure of the alteration in composition which the deposit has suffered in consequence of rise of temperature and increase of pressure resulting from burial in the crust. Observations on the relation between the rank of coals and their distribution in the rocks have shown that change of rank has been caused by geological factors and is quite independent of the original constitution of the seams. This relation is expressed by Hilt's law which states that "in any vertical section the deeper seams are of higher rank than the upper seams". Experimental evidence points to the fact that pressure is more responsible for inducing differences in rank rather than temperature. It is thus obvious that coal can be used as a combined "geological thermometer and barometer".

Zoology.

President: PROF. F. BALFOUR-BROWNE.

THE SPECIES PROBLEM.

PROF. F. BALFOUR-BROWNE in his address on "The Species Problem" questions the validity of Wallace-Darwin concept of the Theory of Natural Selection and comes to the conclusion based on an intensive study of the habits and structure of water beetles that Natural Selection plays but a small part in the origin of species.

The carnivorous group of beetles Hydradephaga and vegetarian group Hydrophilidæ affect isolated habitats which can be grouped as ponds, lakes and rivers and the beetles occupying any one of these habitats form a well-marked community. Each community under an intensive scrutiny reveals a large number of species. This has brought to light an interesting feature that the species composition of a community of insects affecting one habitat differs fundamentally from that of another.

The classification of the habitats into ponds, lakes, etc., is purely an arbitrary one as one passes into the other imperceptively due largely to the frequent changes happening in these habitats. It is interesting to note that a changing habitat is closely associated with a changing community.

Prof. B. Browne discusses further whether adaptation in response to a keen struggle for existence is an explanation sufficient to account for the origin of species. He cites a number of examples to suggest that choice plays a part not merely in determining the food of insects but that it also has a profound influence in the selection of the habitat and draws the inference that neither soil nor plant environment has any direct effect on the community. He suggests that the active factor must be the internecine strife of the animal population.

The purity of a community is usually maintained by the destruction of immigrants and at no time of the year do we find a general mix-up of the communities; for

even new generations seem to emigrate exercising a well-marked choice in the selection of their new habitats. The examples cited show that "Choice plays a part in the composition of these communities." If choice should account for localisation and distribution of species, an even more important rôle is suggested for choice in the study of biological races. By careful experimentation it is possible specially in the case of vegetarian species to induce the insects to develop a decided preference to certain kinds of plants so that we may ultimately succeed in getting at a race of beetles which restricts itself exclusively to that food plant. The changes of habit have not produced any morphological changes to any appreciable degree, though Cameron and Nuttal seem to suggest certain changes in the thickness and length of the antenna and the length of the legs of the insects due to changes in the feeding habits. Nuttal associated these changes with physiological influences.

A study of any group shows that species differ in their relation to one another. Some form clusters while some stand apart. The clustered species of water beetles are usually members of the same community or sometimes even inhabitants of the same districts. In the several examples quoted it is suggested that there is no interbreeding between the related forms and no intermediates have been recognised. However, it is suggested that some clusters may prove to be intermediates between biological races and species.

Prof. B. Browne's study of a series of insects with Deronectes depresses and D. elegans occupying the extreme ends with well-marked specific characters and with an equally well-pronounced geographical distribution may in due course offer an answer to the question whether the climatic or edaphic conditions have a control over species formation.

The inheritance of acquired characters is still a pious hope and proof of it is still lacking. The study of water beetles does not offer any evidence that species characters distinguishing pairs are really heritable. A study of other groups of animals shows that acquired characters do not disappear directly after the stimulus which caused them has been removed.

Work on Drosophila and Oenothera has shown that new characters may arise from changes in the chromosomes of germ cells and the question whether the ancestors of water beetles got into water by choice and then developed adaptive characters or did the changes in form and structure create the choice by reason of which these beetles took to an aquatic life, still remains unanswered.

An analysis of the characters on which classification has based shows that in some cases special structural modifications have enabled the insects to live in water while in others functional changes explain adaptation.

Prof. B. Browne suggests that the species characters are for the most part non-vital and some of the main characters from which the classification of Dystyscidæ is based show a progressive development. These are not vital to their possessors since the various stages in their developments exist side by side and natural selection could have nothing to do with their progress.

The chromosal theory of heredity points to a chromosal control of characters and the orthodenetic tendencies may be the outcome of mutations, caused by external stimulus. Some authors look upon directional evolution as an inherent problem of the organism. If function can cause variation in structure, these evolutionary lines may be responses to the physiological activities assuming that acquired characters are inherited. Inheritance of characters must also depend upon the effect on the germ-cell chromosomes of changes and habits, physiological activity and in the structure of the individuals. The chief struggle for existence seems, therefore, to be in the chromosomes which perpetually endeavour to maintain their normal constitution and relationship.

Geography.

President: PROFESSOR F. DEBENHAM.

SOME ASPECTS OF THE POLAR REGIONS.

THE remoteness of the polar regions from the centres of civilization, and the inhospitable conditions of their climate, no less than the dangers surrounding their approach had delayed their exploration until comparatively modern times; but with the scientific advances recently made in navigation, and with the perfection of equipment for long and dangerous voyages, the search for these unknown areas has been renewed with considerable success. The snowy skies and ice-encumbered seas must make stern demands on the physical endurance of voyagers, and evoke their most heroic

qualities, seldom witnessed under the soft-handed influence of temperate latitudes. In the fifteenth and sixteenth centuries, the motive inspiring the voyages into the unchartered frozen zones of the earth's surface was the desire to discover new routes to China and India for the expansion of trade, and new continents for the extension of territorial boundaries. Although the discovery of more favourable and easy routes to the East, and of new continents for economic development and colonisation, put the political interest in the polar regions temporarily in the background, their geographical problems continued to stir the imagination and the spirit of daring of the voyagers. It may not be the privilege of all geographers, nor even of all the intrepid explorers, to visit personally the drifting of ice-masses and blinding snow storms which surround the Arctic and Antarctic seas. It is, however, within the reach of all to obtain a clear and vivid picture of these strange and weird regions from the published descriptions of the explorers, the accounts of the Press, and the exhibition of motion pictures; and in the perusal of the rapidly growing literature of the polar regions, one is thrilled by the dangers encountered, and is fascinated by the courage and determination of the heroic explorers, so much that one rarely gets a comprehensive view of the territory explored as a whole. This strong human element inevitable in such works, appeals to the emotions of the reader and must account for regarding the polar regions as lying outside the real comity of the world. From the days of Pierre Bouvet and Martin Frobisher down to more recent times, the principal aim of the promoters of the polar expeditions has been one of ultimate gain in securing vested interests in hunting, fishing and mining, and the cryolite mines of Ivigtut and the ivory of primeval mammoths, the furs of seals and bears and the blubber of whales invested commerce in the North with a strange romance.

The story of Arctic adventure and trade has a grim and melancholy aspect in that several of their ventures have brought animal life in the polar regions almost to the verge of extinction. With the progress of long-distance aviation, the idea of using the northern latitudes for passenger and freight traffic in the air has become insistent, and if the greatly improved aeroplanes are diverted from their legitimate purpose, and are used to explore the possibilities of the wealth of animal products, fatal consequences will overtake the most interesting and valuable animals known to science. The cupidity of man and his unwillingness to co-operate are at the bottom of all international troubles. The wealth of the Antarctic and Arctic regions lies in the seas which surround them, which are free to all nations, but their claims to ice-covered land sectors without harbours and without any economic value, have been the subject of international negotiations which illustrate that there is always an aggressive and capricious spirit in international affairs. "It is probably too late for any alternative arrangement to be adopted, but had there been a League of Nations in existence at the beginning of the century, before any claims had been laid in the Antarctic, the protection and administration of this last and least useful continent would have been a most appropriate subject for League administration as an international park of vast proportions which should be open to all nations who would respect its amenities." The passion to possess Antarctic lands arises from the voyagers' tales of their untapped mineral resources and at the moment, nations are apt to forget that they are covered by thick ice-sheets or are rendered inaccessible by topography and climate. Professor Debenham concludes the section of his address relating to the economic survey of the polar regions, by expressing the hope that future developments in the science of physics and of engineering might enable man to harness the Antarctic blizzards and the great ice movements for generating power in the maintenance of industries when coal becomes scarce and oil exhausted, and all the water-power in the temperate latitudes is fully utilised.

If we ask ourselves why so many people have risked their lives in the past by going to the polar regions for other than economic reasons, the answer must be "the lure of the wide open spaces" with their immense solitary grandeur, and the irresistible spirit of curiosity to penetrate the unknown. There is the possibility of the holidays of civilised people, being taken nearer to the polar latitudes, with the increasing rapidity and safety of air transport, and it may not be a fantastic forecast that "there may be a Brighton of Spitzbergen, a resurrection of the Smeerenberg of two centuries ago". The consideration of the polar regions as a holiday resort for the citizens of crowded

cities raises the question of where health is best to be sought. It is true that the temperate zone, provided it is not too far from the sea, is perhaps the healthiest belt for man, but the polar regions are definitely the healthier segments of the earth's surface for the simple reason that the climate though bleak for man must be impossible for disease-bearing vermin. Apart from the healthiness of these regions, the value of their climate for curing diseases contracted in temperate latitudes is an aspect of geographical study worth investigation. Perhaps medical researches on the curative proportions of the air in the polar lands especially in pulmonary affections might yield results which would favour residence in them rather than in the Sanatoria of the Alps, and in such circumstances the polar regions have an importance to mankind far more valuable than all the industries they will ever support. This is an aspect of medical research which falls within the purview of international bodies such as the Rockfeller Foundation, which has done so much for remedial medicine.

Professor Debenham, referring to the value of polar explorations in regard to science, both pure and applied, pointed out that the subject of meteorology was likely in the future to gain most by a prolonged and intensive investigation in high latitudes. The phenomena of magnetism and aurora, which are akin to those of meteorology, are best studied in the higher latitudes which favour investigations of ionosphere. The science of geology, especially in its branch of tectonics though there must be difficulties in the study of rocks covered by sheets of ice, must be interesting the nearer one gets to the axis of earth's rotation. The geologists attached to the British Graham Land Expedition are engaged in the investigation in the Antarctic continent how and where the folded ranges of South America and Graham Land merge into or butt against the faulted escarpments of the Australian Sector of the Antarctic. The discovery of coal beds by Admiral Byrd's geologists, within 300 miles of the South Pole, and the controversies whether the Poles have shifted in the past and whether continents are drifting and other similar geophysical problems must keep the attention of geologists on polar lands. The biological problems of high altitudes, such as the drift of oceanic waters, the presence or abundance of plankton and the movements of the great animals, have already made rapid advances through researches conducted by the Discovery Committee over all the waters of the Antarctic ocean. The value of the polar regions as an outlet to the spirit of adventure and urge for exploration is psychological rather than geographical, and practically in all polar expeditions, the motive is a curious combination of an urge to test the summit of human qualities and a desire to accomplish a great deed for the sake of the deed itself.

The potentialities of these uninhabited zones are undoubtedly great and the interest in the polar regions is bound to become increasingly practical with the progress of our knowledge of the higher latitudes in all their multifarious aspects.

Engineering.

President: Mr. J. S. Wilson, F.C.G.I., Hon. A.R.I.B.A., M.I.C.E.

THE STABILITY OF STRUCTURES.

The meaning of stability is not easy to define. In dynamics and mechanics we have stability of steady motion and stability of equilibrium of position and of friction. In civil engineering it is usually applied to the power of a structure to withstand for an indefinite time all the loads and forces that may be brought to bear on it.

The great pyramids of Egypt, the tall brick chimney that stood till recently at St. Rollox in Glasgow, the masonry dams built across valleys to impound water and arches constructed across rivers and in great buildings are good examples of stable structures. The strength and stability of these structures depend mainly on the resistance to compression offered by the materials, *viz.*, stone or brick. In the case of the complimentary form of structure, such as a suspension bridge, they depend almost entirely on the tensile resistance of the chains or cables. In most iron and steel structures such as girder and canti-liver bridges the resistance of the material to both tension and compression contributes to their stability in equal proportions. In reinforced concrete the great strength of concrete to resist compression is combined with the power of steel to resist tension. Due to the facility with which it can be built and shaped it has been applied to many large structures which present problems in stability of considerable interest. Tunnels of masonry or brickwork and cast-iron lined tube tunnels, subject to the pressure of great depths of earth, are forms the stabilities of which are not easy to calculate.

In estimating the stability of a structure the principal factors are the strength or resistance to rupture of the material and the balance or direction of the forces or loads brought to bear on it. In structures subjected to prolonged stress the factor of safety is a vital consideration and the correct factor of safety to be adopted, in each individual case, has still not been accurately fixed and, so far as civil engineering structures are concerned, the advance made in this direction has not been very great.

The rupture or breaking down of a structural element by a force is dependent on the detail of its incidence and the resulting intensity of the stress induced in the material.

The conception of action of forces along lines was introduced at an early stage. The position of such a line with respect to the boundary of a member offering resistance governs the distribution and intensity of the stresses in the material. In estimating the intensity of stress the position of the line in a lamina of the part under consideration is usually considered and in it the distribution of the stress follows the "Trapezium Law" which is a particular case of Galileo's solution of the beam problem.

In a pier or buttress which supports and at the same time resists the thrust of an arch the line representing the resultant of the weight and thrust of the arch is deflected downwards by the weight of the buttress and the shape of the structure has to be so decided as to keep this resultant line of pressure as far as possible near to the centre of pressure so as to obviate very high concentration at one end or appreciable tension at the other.

This rule applies to all cases of masonry such as ordinary walls, abutments, piers, retaining walls, dams and arches.

In this connection the problem of the masonry arch which is very interesting deserves special mention. The arch form of construction has been known for thousands of years and several magnificent arches built by the Romans are still in very good state. Although the arch form of construction was generally used there was always a feeling of uncertainty as to their strength and stability.

Up to the first half of the 19th century knowledge of the strength and characteristics of materials and of applied mechanics was not sufficient to establish or disprove the accuracy of the various theories propounded from time to time and any efforts made in the problem depended almost as much on dialectics as on mechanical principles. Throughout the 18th and 19th centuries mathematicians tried to find the exact form of the line of thrust that would ensure equilibrium in a mass of masonry bridging a void bounded by the horizontal line representing the road on the top and the intrados of the arch at the bottom shaped to conform to the line sought. The effect of hollow spaces over the haunches was investigated also and the influence of a moving load was regarded as negligible.

The correct shape of the arch to be adopted was also a point in dispute and the indefiniteness on this point was so great that about the year 1759 a controversy arose between the two designs submitted by two persons, Mylne and Gwyn, for a bridge, across the Thames at Blackfriars, one with an elliptical arch and the other with a semi-circular arch, and it was held that elliptical arch was stronger than a semi-circular one contrary to the every-day experience of the egg being weaker along the sides than on the ends.

Differences of opinion on the correct proportions of an arch also were very sharp. Some maintained that the thickness of an arch at the crown should be proportional to the radius of curvature while others held that the span of the arch should be the governing factor.

These contradictory opinions of the people who were considered to be authorities on the subject did not help architects and engineers who went on taking additional precautions by binding stones with iron cramps and for many years architects and builders were extraordinarily lavish in their use of cramps even in places where they could have no beneficial effect, notwithstanding the fact that these cramps did more harm than good to structures by corrosion.

Fine masonry arches of 300 feet span have been built. The construction of arches of larger spans has been made possible by improved technique in building. For longest spans reinforced concrete has now superseded masonry and arches with spans as great as 590 feet have been constructed.

In his monumental work called *Grandes Voutes* Paul Sejourne has given particulars of all arches of appreciable size throughout the world with details of construction and comparative analysis of the proportions. But the mathematical theory of the stability and strength of the arch, however, is of comparatively recent solution, due mostly to eminent engineers like Unwin and

Rankine. It may be added that Rankine's mathematical treatment of the subject has been further developed by his pupils, Alexander and Thomson.

The problem of the stability of masonry dams had exercised the minds of engineers and mathematicians for many years and the failure of the Bouzey dam in France in the year 1895 gave prominence to the subject. The maximum pressure on the masonry was the only factor considered in calculating its proportions in designing it and it was held by some that the failure was due to its incapacity to withstand the great tensile stress brought to bear on it and by others due to shearing. After the disaster, the French Government introduced a regulation that on horizontal joints of dams there should be a vertical compressive stress at the water face equal to not less than the water pressure at the joint. In 1904, Prof. Karl Pearson and Mr. Atcherley published a memoir entitled "Some Disregarded Points in the Stability of Masonry Dams" in which they stated that although a dam might satisfy the usual conditions regarding the stress on horizontal planes, it might still be subjected to dangerous tensile stress on vertical planes in the vicinity of the down stream toe. But the elaborate and careful experiments held jointly by the late William Gore and the President on these points showed no evidence of the tensile stress at the down stream toe; the shear stress diagram was practically a triangle with the maximum at the down stream edge and the vertical stress distribution agreed substantially with the Trapezium law. These experiments helped to re-establish the confidence in the method that had been in use for estimating the stability of masonry dams. During the last few years, investigations, both experimental and mathematical, of problems relating to the design of concrete dams and curved dams have been made in the United States. The influence of heat, both natural and that generated by the setting of cement, on stresses and stability has received much attention.

The suspension bridge is a fascinating type of structure and there have been astonishing occurrences in the course of the development of its design and stability. Suspension bridges formed of strong flexible climbing trees or roots have been used by primitive people. Examples made of wrought iron appear to have been in existence in the eighteenth century. Telford's famous bridge across the Menai Straits with a span of 570 feet completed in 1826 and one built across the Thames at Marlow by W. Tierney Clerk, F.R.S., in 1829 are still in use. The former is of the simple suspension type; the latter was the first to be built with stiffening girders. A supposed improvement was introduced by a Mr. James Dredge in 1836, which was much applauded and several bridges were built according to his specifications, some in England and some in India, all of which however failed. These failures created a strong prejudice against suspension bridges of all kinds and retarded their development.

The flexibility of the suspension bridges under heavy moving loads is a source of trouble and of wear and tear of the platforms. Nevertheless, when the chains are pulled by the loads into a line of equilibrium, so long as the anchorages are secure and the towers are sound, the stability depends solely on the tensile strength of the chains, and under these conditions almost all suspension bridges have a substantial margin of strength or stability. If over-loaded, long before the rupture of the chains would occur, the sagging or deformation of the platform would act as a warning. Where the ultimate strength depended mainly on the resistance to compression of the platform, as in Dredge's bridge and others built about the same time, the failure by the buckling would be sudden and disastrous.

In the modern suspension bridge the stiffening girder is as important a feature as the chain or cable and its introduction has made it possible to construct the gigantic bridges in the United States. The latest example is of a span of 3,400 feet. Cables composed of thousands of steel wires, four times as strong as iron, take the place of iron chains and the flexible timber platform has been replaced by deep steel stiffening girders with upper and lower decks providing double tracks. Instead of the stability of the structure being a matter of dispute and of the extraordinary uncertainty as before, the stability is now determined and gauged by calculation based on applied mechanics.

Anthropology.

President: SIR ARTHUR S. WOODWARD, F.R.S.

RECENT PROGRESS IN THE STUDY OF EARLY MAN.

SIR ARTHUR WOODWARD'S address on the recent progress in the study of early man is a

condensed account of the researches leading to the establishment of a number of genera of prehistoric man known to-day. Sir Woodward is admirably fitted for his task, being not only an anthropologist but a geologist and a palæontologist as well.

Any history of early man is closely bound up with the history of mammals associated with him as well as the implements he used. And a correlation between these three factors is a study which has often received scant attention and the more than usual interest in the address lies in the fact that Sir Arthur Woodward has taken all these facts into consideration in adjudging the value of the different human remains.

The most significant fact that has emerged out of the studies on fossil man is that man did not originate in Europe and the fossils known from this continent belonged to men who were immigrants from some other region. The investigations of Sir W. Boyd Dawkins on the mammals associated with early man in Europe have all pointed to the same conclusion, that they are immigrants from the Arctic regions, from Asia or from Africa. Africa as the home of early man is known only by a single skull of uncertain age named Australopithecus by Prof. R. A. Dart in 1925. While this skull which belongs to an ape certainly shows more human characters than does that of any other existing ape, a complete account of it is still being expected. It is on the other hand more likely that the origin of man is to be traced to Central Asia and the geographical distribution of the known fossils of early man is quite in consonance with this view.

The geological age of Eoanthropus from Sussex is the most difficult to determine but a close examination of the nature of the stratum as well as the mammals that occur associated with this fossil goes to show that Eoanthropus belongs to the beginning of the Pleistocene age. The difficulty is much less in the case of *Protanthropus heidelbergensis* which was found in association with mammals typically lower Pleistocene and it is the general opinion that it is unlikely that there is much difference in age between the Piltdown and Heidelberg men.

Pithecanthropus, discovered in Java, has been said to belong to the beginning of the Pleistocene period. The more recent Sinanthropus found in a cave in China and associated with a number of characteristic mammals and even with the remains of fires, seems to have been a contemporary of Eoanthropus and dates back to the early Pleistocene period. This latter skull is important in that it combines the characters of the other skulls.

Geologically latest is the Neanderthal or Mousterian man and this marks a fresh stage in the history of the evolution of man, since by this time man had learnt to bury his dead. Later discoveries of the Neanderthal man in Palestine have definitely enabled us to think that here is the modern man in making.

Dealing with the fossil remains of man found in other continents Sir Arthur Woodward points out that the fossils found in Australia relate to a fairly advanced type of modern man, as Australia was separated from the rest of the world throughout the tertiary age. The fossils in North America are also recent and relate only to the later part of the Pleistocene age. The work of Dr. Peter Wilhelm Lund in South America also points to the same conclusion.

Physiology.

President: PROF. P. T. HERRING, M.D.

THE PITUITARY BODY AND THE DIENCEPHALON.

THE address is devoted to considering the anatomical and structural features and the functional activities of the pituitary body which until recently was an organ of great speculative interest. In 1832, its dual mode of origin was discovered, the gland being composed of a ventral evagination of the twixt brain (the nervous lobe) and an epithelial accession (Rathke's pocket) from the buccal cavity. This union of buccal epithelium with the nervous element appears indeed to be to some extent a symbiosis, a view which is supported by experiments of transplantation. The coming together at an early stage of development of the pituitary body of two hollow processes, the one from the dorsal surface of the buccal cavity and the other from the ventral wall of the diencephalon throws light on an obscure point in the evolutionary history of the vertebrates, containing perhaps a suggestion that the union denotes an old association between the alimentary canal and the nervous system not unlike what occurs in the invertebrates. Thus Rathke's pocket may be regarded as the vertebrate representative of ancient invertebrate mouth (Palæostoma) and a comparison of the pituitary body with the ascidian subneural gland as homologous structures is often

made in Zoological works. The history of the pituitary is one of great significance, and the epithelial components make up the greater part of the organ in all vertebrates, forming the pars glandularis (anterior lobe), the intermedia (intermediate lobe) and pars tuberalis (tuber cinerium). The fourth part, pars nervosa, is the derivative of the twixt brain.

The anterior lobe contains chromophobe cells (mother cells), which make up the greater part of pars intermedia,—which are able to give rise to acidophil and basophil cells. There is evidence to show that chromophobe cells with filamentous golgi networks give rise to acidophil cells and those with perinuclear golgi rings, to basophil elements. The relative proportion of these cells is liable to variation in the different parts of the pituitary and also in the same part under different physiological conditions. The histological character of the pituitary can be varied and changed rapidly.

The epithelial lobe, whose circulation is sinusoidal, provides for its secretion to enter the blood directly, which is obviously destined more for general purposes in the body than for action localised to its immediate neighbourhood. The posterior lobe (pars nervosa) contains granular particles, derived most probably from the epithelial investment and the ependyme cells and secretes the pressor substance and other hormones which in their activities do not differ from the extracts of the epithelial lobe. The secretion of the posterior lobe may be absorbed into the blood vessels, penetrate the adjacent nerve floor and also enter the cerebro-spinal fluid.

The pituitary body is closely bound up with the floor of the third ventricle, and non-medullated nerve fibres arising from cells in the supraoptic, paraventricular and inferior hypothalamic nuclei have been traced to pars intermedia, pars tuberalis and islands of epithelium in the pars nervosa, besides sympathetic nerve fibres and the carotid plexus. Experimental work supports the view that the nuclei in the diencephalon exercise a controlling influence upon the secretion of the pituitary, as is shown by the observations on the female rabbit, the removal of whose pituitary within an hour after copulation (but not later removal) prevents ovulation. An injection of the extract of the anterior lobe brings about ovulation, and it is reasonable to infer that the stimulus of mating induces reflexly in the rabbit sufficient hormone for the purpose in about an hour's time. Zondek refers to the pituitary sex hormone which sets the reproductive cycle going, and Harvey Cushing comments that the emotional self-starter resides in the diencephalon. Evidence is accumulating that the hypothalamus (comprising the tuber cinerium, copus mammilare, infundibulum and pars nervosa of the pituitary body, optic chiasma and subthalamic tectal region) is an important site of integration of the basic activities which are common to the life of all vertebrates. The pituitary body is an essential part of hypothalamus which controls the metabolism of solids and water, with its accompaniments of hunger and thirst, the regulation of body temperature, emotional reactions, sleep, mating and reproduction.

Hormones have been separated in more or less pure form from the anterior lobe which stimulate growth and exercise a controlling influence over many important organs of the body, the glands, thyroids, parathyroids, thymus, cortex of the suprarenals and the mammary glands. The gonadotropic hormone is probably a product of the basophil cells. Harvey Cushing and his co-workers have drawn attention to the changes in carbohydrate metabolism which are exhibited by patients and experimental animals in hyper and in hypo-pituitary states, and injections of anterior lobe extracts have been found to produce ketonuria, lipæmia and cholesterolæmia, in addition to hyperglycæmia and increased resistance to insulin. The posterior lobe furnishes an extract pituitrin which contains two active principles, a pressor substance (β-hypophamine, vasopressin or pitressin) and a substance acting upon uterine muscle (α-hypophamine or oxytocin). The hormone of the posterior lobe extract which produces a diuretic action, probably resides in vasopressin. Harvey Cushing expresses the view that the grey matter in the hypothalamus, possibly the nucleus supraoptics is an important cell station for the integration of nerve impulses regulating water intake and output, and that the hypothalamus and the posterior lobe of the pituitary body make up a neuro-epithelial structure, the parts of which are mutually interdependent in their functions. A multiplicity of actions can be evoked by the extracts of the posterior lobe but it is doubtful if all of them are normal functions.

The diencephalon and pituitary body form a working unit, having functions of far-reaching importance in the control of fundamental physiological processes. It is probable that the pineal body is another part of the same mechanism, but its functions are still obscure.

Psychology.

President : DR. LL. WYNN JONES.

PERSONALITY AND AGE.

DEFINING personality as an integration of all the marks of mind and body as affected by nature and nurture, Dr. Wynn Jones presents a most interesting review of recent attempts to correlate it with age. He accepts five great classes of factors in personality, namely: (1) intellect, (2) disposition, (3) temper, (4) temperament, and (5) character, regarding them as largely, but not entirely, independent variables in the weaving of personality. Difficult as are the qualitative aspects of the problem, their quantitative assessment presents at the moment almost insuperable obstacles, because among other fogs enveloping the subject, recognition of the onset of senility is astonishingly variable. The German investigator, Giese, lately invited newspaper readers to declare the age at which they first noticed signs of advancing years, and to specify the signs: analysis of the replies placed the average at 49, but the age varied with the individual from 18 to 82! What can you do with that?

This inquiry, although doubtless amusing to the newspaper readers, does not strike the layman as contributory to the investigation, because while some people notice the passage of years by disabilities of the body, others are more impressed by changes in the mind. Moreover, in the latter class, 38 per cent. recognised their increasing age by treatment received from associates, while 44 per cent. relied on self-diagnosis: it is curious to note that the remaining 18 per cent. resisted the suggestion of senescence altogether, some with indignation. Whether contributory or not, however, it does illuminate the complexity of the subject, compared with which the study of child-psychology, a happy hunting-field for psychologists during the past thirty years, is almost child's play. Nevertheless, attempts have been made to extend, with suitable modifications, the methods of child-psychologists to the subsequent five or six decades of human life, and some of these are helpfully reviewed by Dr. Wynn Jones.

Among them is E. L. Thorndike's *Adult Learning* (1928), which examined the changes in (1) amount, and (2) nature of the ability to learn displayed between 15 and 45, especially between 25 and 45. One definite outcome is that nobody under 45 need shrink from trying to learn in the belief that he is too old to learn. This is good news for the opsimath, or late learner, and an authoritative encouragement of university extension courses. "If he fails in learning it, inability due directly to age will very rarely, if ever, be the reason. The reason will commonly be one or more of these: He lacks and always has lacked the capacity to learn that particular thing. His desire to learn it is not strong enough to cause him to give proper attention to it. The ways and means which he adopts are inadequate, and would have been so at any age, to teach him anything." Here psychology confirms commonsense, and in this connection there should be noted a conclusion of W. R. Miles, namely, that when speed is the stressed element in an intelligence test for adults, then the decrement due to age is greater than it is when power in unlimited time is emphasised.

Quantitative results are more easily obtainable in the athletic field studied by Professor Charlotte Bühler (1933) to ascertain the effect of age on various motor abilities, from which it appears that those demanding a maximum expenditure of energy per second are associated with the youngest average age, while older athletes excelled in exercises demanding economy of effort and its optimum distribution. Thus the following scale emerges:—sprinters and long-jumpers (23·5); hurdlers, high-jumpers, pole-vaulters and weight-putters (24·5 to 25·5); long-runners, rowers, weight-lifters and hammer-throwers (25·5 to 31·0). In group sports distinguished from individual contests the sequence was:—boxers (21·9); wrestlers (22·3); footballers (23·8); hockey players (26·4); tennis players (28·5); polo players (up to 50). To these Dr. Wynn Jones adds (for 1934) cricketers (30 for batting, 30 for bowling; 34·5 for those exceeding 3,000 runs) and golfers (35 as the median age of the forty who headed the open championship; and 31 as the median age of thirty-seven open champions since 1894).

One of the most baffling and least easily

measured factor in assessment of personality is temperament, *i.e.*, as defined by psychologists, the influence, direct or indirect, of bodily metabolism upon the psycho-physical processes of the nervous system; but the address does not expand this vitally important element. In passing, it may be questioned whether this definition of temperament coincides with common acceptance, the above-mentioned influence in the lay mind being that exerted by general health, while temperament usually connotes a predominant quality, as in 'lively temperament,' or 'phlegmatic temperament'. An appreciation of the recently published *Diary of Robert Hooke* (*Nature*, September 7, p. 358), to which Professor Andrade has gracefully brought his wit and erudition, makes it clear that Hooke, "generally allowed to have been one of the greatest promoters of experimental natural knowledge, as well as ornaments of the seventeenth century" (Richard Waller), was a permanently sick man, victimised by chronic inflammation of the frontal sinuses. Nevertheless he passed the sixty-seventh year, but the temperamental effect of his disorder, his crooked figure and his shrunken limbs cannot be computed; how confusing to the age-personality connotation, therefore, would have been his treatment by modern therapy. Every middle-aged man can recall from individual experience unfortunate examples of personality influenced by health; so much so that the benevolent minded, in contact with a thoroughly objectionable temperament, instinctively seek a physical explanation, and commonly find it.

Another factor in personality not merely unexpanded by Dr. Wynn Jones, but even unmentioned, is matrimony. To the Indian observer this may not seem important, because in this country (*a*) to remain unmarried is most unusual, and (*b*) matrimony appears to present less variable impingements on personality than among Western peoples. In the other hemisphere quite a significant proportion of people with personality inviting study remain unmarried, while those who do venture on matrimony cannot escape a modification of their personality, sometimes profound, owing to its influence. This is perhaps more conspicuous in the United States, but it is easily recognisable elsewhere. Reduced to a simple form, this factor would involve examination of the woman's personality in addition to the man's, a complication giving fresh terror to this branch of psychological inquiry—or further attraction, according to the age and personality of the investigator.

Botany.

President: F. T. BROOKS, M.A., F.R.S.

SOME ASPECTS OF PLANT PATHOLOGY.

BIFFEN'S discovery that susceptibility and resistance of wheat varieties to yellow rust are inheritable characters, led plant breeders to evolve new varieties of crop plants, which while retaining the valuable commercial qualities of the older crops, would resist specific diseases. Genetical and selection methods have led to the successful control of certain wilt diseases but in certain cases the plant breeder is faced with almost insuperable difficulties, since there is often complete or almost complete linkage between susceptibility to a specific disease and high quality which is extremely difficult to break. Another problem which the plant breeder has to face is the fact that one crop is liable to attack by several diseases and resistance to one disease is transmissible independently for each specific disease. Again he has to reckon with the fact that a variety bred for resistance in one locality may become susceptible if transferred to a different environment.

Parasitic organisms are liable to evolutionary change just as their hosts are and one cannot therefore postulate that their parasitic proclivities will remain constant over long periods of time. New physiologic forms evolve both by hybridisation and by mutation, and this capacity of micro-organisms to change, introduces enormous complications into the problem of disease control.

Another advance in the control of plant diseases lies in the greater attention now paid to plant sanitation or plant hygiene. Such preventive treatment, following the same lines as in medical and veterinary sanitation, aims at the abolition of the sources of infection wherever possible. The efficacy of plant sanitation is best seen in intensive cropping in fruit plantations and under glass. For instance, by preventing the fungus *Stereum purpureum* from spring within and on the confines of fruit plantations, risk of Silver-leaf disease is appreciably reduced.

Seed-borne diseases are controlled by fungicidal treatment of the seed before sowing, the control of some epidemic diseases by spraying the shoot system with fungicides, and the

protection of wounds in woody plants against parasitic invasion have met with a considerable degree of success.

More care is now paid than formerly to growing plants under the best environmental conditions with a view to diminution of parasitic attack, including modifications of cultural practice which tend to favour the host at the expense of the parasite. The ecological study of disease in plants is only in its infancy, but it promises to be one of the most fruitful aspects of plant pathology.

Another branch which is receiving much attention at the present time and which will probably assume greater importance in the future is the influence of one micro-organism on another in the establishment of disease.

The effects of associations of micro-organisms in culture are often profound. A mixed culture of two organisms can often produce a result which neither of them alone can induce. Such an effect has been termed "synergism" by Holman and Meekison. One organism may change the substratum so that it becomes suitable for the growth of the other, but the interactions of the two associates on the original medium are sometimes of a more intricate nature.

The effect of micro-organisms on one another is frequently also one of antagonism. Two organisms may mutually inhibit the development of each other, or one may be greatly impeded in its growth by the other. In the latter case one organism may exercise some toxic influence on the other or it may utilise the available food material so rapidly as to starve the second organism. Factors of this kind may perhaps play an important part in the specificity of saprophytism exhibited by certain fungi.

Of particular interest and of great importance is the antagonism shewn by certain saprophytes to pathogenic fungi which invade the underground parts of their hosts: indeed it is not too much to say that a new chapter in soil microbiology has been opened with the recognition of this factor of biological antagonism. In 1923, Millard demonstrated that *Actinomyces scabies*, a commonly occurring soil organism which causes potato Scab, could be prevented from attacking potatoes by incorporating large quantities of green manure in the soil.

During the early development of plant pathology little attention was paid to the study of disease in plants of a functional kind, *i.e.*, to disease not induced by parasitic agency. In certain ways non-parasitic diseases of plants are more difficult to investigate than those due to parasites, and not much progress can be made with the elucidation of some of them until more is known about normal plant physiology. Warrington and Brenchley startled the botanical world some years ago by demonstrating that boron was an essential element in the proper nutrition of certain green plants. Since then Brandenburg has suggested that boron-deficiency in the soil is the cause of the serious "heart-rot" disease of sugar beet and mangolds. Another element having the property—formerly unsuspected—of exercising an important rôle in the nutrition of some plants is manganese. It has long been known that oats did not thrive on certain soils unless salts of manganese were added. On such land the oats were stunted in growth, the leaves were affected by grey blotches, and the plants died prematurely, the disease being known as 'grey leaf' or 'greyspeck'. Small amounts of manganese sulphate applied to the soil enabled a healthy crop to be grown. Samuel and Piper have shewn by careful experiments that minute quantities of manganese must be available in the soil to allow of the normal nutrition of oats and certain other plants. Such a disease as that of 'grey leaf' of oats is now known as a "manganese-deficiency" disease. Another interesting example of the importance of nutritional factors in the maintenance of well-being in crop plants is afforded by the researches of Storey and Leach on a grave disease of tea bushes in Nyasaland, which causes chlorosis and rapid death. They have demonstrated that this disease is due to insufficiency of available sulphur in the soil.

Educational Science.

President: DR. A. W. PICKARD-CAMBRIDGE, D.LITT., LL.D., F.B.A.

EDUCATION AND FREEDOM.

THE address is devoted to examining the two opposite tendencies at work in the world of modern Education; the one, a tendency more or less antagonistic to freedom and the other, a tendency laying claim to freedom in ways which it is not always possible to defend. The latter is reflected in a number of educational theories which

would so far as possible exclude discipline from life in the supposed interests of free development, and also in a certain impatience with all forms of authority, manifested by the younger generation. But the other tendency is the outcome of the political doctrines adopted in countries such as Russia, Germany and Italy, where we witness a complete subordination of the individual to the State, not only in his external life and action but also, so far as education and propaganda can achieve it, in thought and will. In all the three countries the method adopted is the same, namely, anything which runs counter to the ideas promulgated by the dictator is sternly discouraged. This phenomenon is not confined to Central Europe and its manifestation even in democratic countries is discernible. The great feature of party government in England is party discipline, which essentially deprives the individual of all freedom of action and speech, and the members of the party have to subordinate their opinion and will to the interests of the organisation to which they might belong. Naturally the schools managed by such parties will gradually acquire the rigidity under which the political organisations conduct the public affairs.

Some of the recent works in fiction such as Aldous Huxley's *Brave New World* and H. G. Wells' *The Shape of Things to Come* which are most popular with the younger generation, clearly envisage and apparently approve the political and educational systems based upon the complete elimination of individuality. "Democracy," says Wells, "asks people what they want; what is required is to tell them what they want and see that they get it." His new government was meant to rule not only this planet, but the human will. It is open to treat such works as fiction but the events of our own times show that the constructors of imaginary Utopias are almost prophetic. It has been shown in most countries that it is possible so to educate and to govern as to eliminate freedom of thought and life and to make human beings efficient cogs in an all-embracing machine and to convince them that that is the best life for them. The acceptance of such views in the political organisation will lead to a passive acquiescence of them in the field of education, with the consequence that the curricula of studies, the methods of imparting instruction and the teachers and pupils must come under a thorough-going espionage.

But is it not a fact recognised and practised from ancient times that individual freedom, subject to such a minimum of restriction as is necessary for life as a member of a community, is the indispensable condition of a good and even tolerable existence? Plato and Aristotle thought that it was the business of education to bring up young citizens in what they called the 'Spirit of Polity' and it makes all the difference in the world when Russia, Germany and Italy substitute the word 'State' for 'Polity'. Where the State assumes the authority for directing and controlling education, the result must inevitably be a standardised and unresisting mentality, which education in the spirit of a polity of free men and women must above all train them to think freely and accurately and to desire to carry the results of their thinking into action. Such a freedom includes the power of the individual to realise the good, as he understands it, in his life, and the power to take an equal share with any other citizen in determining the action of the community in the realisation of public good as a whole. So far as the community is concerned, the ideal state will be a democracy in which every individual is free to realise the highest values, physical, moral and spiritual; and the realisation of some of these is only possible if he can enter into freely determined mutual relations, with others, participating fully in the life of the community, communicating his share of good to it, receiving his share of good from it.

Freedom desired for the individual encounters obstacles of more than one kind; and it is in a great measure with these that education has to deal. They are partly in himself, partly in the community. The powers of an individual to make a free and correct choice from out of the lower and higher values, obviously depends upon the training, as well as upon his natural endowments. Every one is greatly hampered by the effects of heredity, and by the influence of early environment. The whole process of education is to set the higher values before the immature mind in such forms as it can understand and encourage the habit of choosing them. The importance of such discipline depends upon the fact that without it, the immature personality may not discover that it has the freedom, to choose something other than that which immediately appeals to it. Discipline, correction and guidance reveal the power of choice; in

time self-discipline follows and freedom to pursue and realise ends or values increases. Much of the discipline imparted by education in the cause of freedom is apt to be counteracted by the faiths, prejudices and party feelings of the community. The interests of communal organisation do not always coincide with those of education and more often than not, the purpose and intentions of education are vitiated by personal rancour and malice of those entrusted with its management.

It must be remembered that before life is far advanced the simple problems and issues of early life are merged in far more complicated issues of the community, requiring the utmost clarity of thinking. For effective thinking the younger generation should have access to truth about facts and the mind should have been disciplined in the habits of working accurately and honestly. If freedom in political and private life is to be preserved, those who educate young men must put them in the way of obtaining truth about facts and of distinguishing truth from falsehood in what is presented to them and in their own reasoning. It is in this way that they can be trained to citizenship in democracy and to the conception that it is less a system of equal rights than a system of equal responsibilities and co-operative endeavour for the good of the community as a whole.

Dr. Pickard-Cambridge examines the relative values of the school subjects which afford opportunities for the formation of habits of careful and correct judgment. The task of the teacher is to encourage his pupils to think by the presentation of evidence or of opposite points of view; the desire of the politician is to prevent his adherents from thinking so that they may swallow his particular notions. It is in the school room that the dangers of dependent, unventuresome and servile mentality must be countered. Young people are much more likely to think for themselves within the framework of school discipline (which is scarcely felt so long as it is wisely controlled) and do think for themselves. Dr. Pickard-Cambridge next proceeds to observe how the system of public examinations as they are at present planned and conducted, militates against the results of education.

The suggestions made in the Presidential address as regards educational theory and practice are no matters merely of finance, administrative and political convenience, but of vital and immediate urgency if we are not unconsciously to bring up a race, which with its mind stunted, its capacity for freedom undeveloped, will fall an easy prey to the politician, the journalist and the dictator: and that if a free democracy is to continue, we must educate for it, for in many respects, the present educational practice is better calculated to produce a servile and passive mentality than to evoke an activity of mind and freedom of judgment worthy of free men and women.

Agriculture.

President: J. A. VENN, LITT.D., F.S.A., J.P.

THE FINANCIAL AND ECONOMIC RESULTS OF STATE CONTROL IN AGRICULTURE.

THE Presidential Address of Dr. J. A. Venn before the Agricultural Section of the current year's session of the British Association for the Advancement of Science deals not with any aspect of the service or practice of agriculture but, as the above title indicates, with some of the economic factors upon which the prosperity of agriculture is coming to depend more and more in recent years. It does not seem to matter how high or low efficient one's production may be, it is really, on the other hand, the price one's produce is able to fetch that is the deciding factor. This would indeed be a truism hardly worth stating were it not that in the modern state the prices of commodities are not regulated in the way known to economists by the interaction of demand and supply in a world market but by a whole battery of protectionist weapons, both offensive and defensive, whose result cannot be foreseen and which have to be constantly changed and adapted to varying conditions. It is the story of how Great Britain leaves off her *laissez faire* free trade policy and falls into line with the universal protectionist tendencies of the world, to what extent this change of policy has brought relief to agriculturists, what the cost has been to the State Exchequer, how conflicting interests like those of the home producer, manufacturer and the Empire producer, or again those of the consumer, middlemen, landlord, tenant and agricultural labourer are sought to be served and what a variety of purposeful measures of State action these have introduced—it is the story in fact of their new economic regime of the latest convert to protectionism and State control that Dr. Venn unfolds in his address. Frankly, he plays the rôle of only an

'expositor' and gives us little more than a narrative of these developments together with a picture of their historic background without attempting any criticism of the merits or imperfections of the measures or offering any suggestions or alternatives, or developing any particular theme or view. He alludes, however, in passing to various dangers and risks to which this kind of elaborate artificial propping by means of State control and aid may in time lead. It is not difficult to see that his sympathies are with the old-time free-trade policy and that like most British people he looks upon these measures as a necessary evil, perhaps only temporary in character to give place in time to the free play of natural forces whose result will admit of a reasonable amount of forecasting and of suitably providing against. He quotes the following dictum uttered recently by one of the world's dictators:—"What the situation calls for is the free movement of goods, of people, of capital and of credit," and adds that "We in these islands have more to gain than any other nation by such a consummation." This consummation is, we are afraid, a long way off, and will like the horizon keep moving farther and farther as long as nations can set no limit to their ambitions of conquest and domination, political or economic.

In his historic survey, Dr. Venn traces the close parallel that exists between the remedial measures against the depression at various periods including the present one and that many mistakes and much needless expenditure of money could have been avoided if only this parallel had been better known. The results of successive acts of amelioration by the State during the past are described, such as the wiping out, by remission of a big load of agricultural taxation, the provisions for the better housing, education and health of rural workers, the institution of small holdings and the provision for agricultural research and technical instruction for the farmers. Attention is also drawn to the change in the farming methods that has proceeded side by side with this State action, by which the British farmer turned from arable farming to the more remunerative fields of dairying, the production of fruit, vegetable and other foodstuffs of a luxurious character. The story is brought down to the period of the Great War and the rigid State control of agriculture necessitated by that crisis. Into this, however, the address does not enter, for Dr. Venn's main theme relates to the peace time activities of the thirteen-year period subsequent to 1922, during which the new measures of State aid and protection have been in full blast. He divides those thirteen years into two distinct periods, the first one being the period of subsidies, grants-in-aids and reliefs from taxation, and the second that of the control of home production and of imports accompanied by the imposition of protective duties. The several measures under the first are duly catalogued, their features being only broadly indicated, and the monetary gain to agriculture itemised and estimated. The estimate is interesting and is as follows:—wheat deficiency payments, £ 7,180,000; sugar-beet subsidy, £ 2,820,000; meat subsidy, £ 3,300,000; milk grants, £ 1,600,000; small holdings and allotments grants, £ 900,000; afforestation grants, £ 450,000; ministry of agriculture and development commission, £ 2,500,000; tax remissions, £ 15,000,000;—making up a total of £ 33,750,000. A deduction of £ 10,250,000 is made on account of payments by statutory wages by farmers bringing the total net gain to British agriculture to £ 23,500,000. The result has been an increase in the acreage of wheat, a new and prosperous beet sugar industry, an increase of 50% in milk cattle and so on, all of which may be taken to justify the expenditure incurred by the new policy. Dr. Venn points out in this connection that the chief beneficiaries of these grants have been the tenant-farmers and agricultural workers, but not the landlords, whose position has continued to deteriorate. But the landlord's wail is a familiar cry all the world over, for the tendency throughout has been to assist the actual farmer, be he owner or tenant, and to take little notice of the mere rent-collecting owner, and even in England, the drastic step of State ownership of all land with a system of granting land on a cultivating tenure has been proposed by land reformers.

The second set of measures comprises the restriction of imports, improvements in home marketing methods for capturing the home market, the enactment of marketing Acts, and trade agreements fixing export quotas from foreign countries. The increase in price brought about by these measures, Dr. Venn estimates at some £ 17,000,000 of increased receipts to the producer, which added to the gain from the

direct grants and remissions, brings up the total gain to agriculture to £ 40,000,000. In respect of these measures too, Dr. Venn refers to the almost revolutionary break with the age-long British tradition implied by the powers granted under the marketing Acts, whereby "co-operation" is made "compulsory". Mention is also made of the irksome red tape, supervision and interference by officialdom which one has to put up with, not to speak of the penalties and fines imposed for infraction of the Act. All this is no doubt true, but the bulk of even the latest opinion is solidly in favour of a continuation of the various subsidies (including the much-debated sugar beet subsidy), the milk 'pools' and the various other measures of State control. The nation is evidently quite willing to pay this price for the well-being of its agriculture.

There is, we cannot help noting, a strong under-current of disapproval of these measures running throughout the address which does little justice to the aims in view or the unavoidable difficulties that beset their attainment. When all is said and done, British agriculture cannot adequately feed the British people, and there was a time when hardly a quarter of her food requirements was produced within her limits and it is a well-kept war-time secret that during the winter of 1917–18 food stocks had run so low that proud and wealthy England was perilously near starvation. Such a situation, it would obviously be suicidal to allow to recur and it is not difficult to appreciate the outlook of British statesmen. To enable British agriculture to support her population out of her own resources if possible or supplement by Empire resources if necessary, is evidently the objective; to gain this end all these superhuman endeavours are being made. Dr. Venn himself testifies to the results that have already been achieved in the desired direction and this should be the justification for the vast sums being expended for the pursuit of the economic 'heresies' and the unwelcome encroachments of the State on the liberty of the individual. One wishes, on the other hand, that here, in India, our own Government would accord to Indian agriculture a suitable measure of similar support and financial help.

Conference of Delegates of Corresponding Societies.

President: PROF. P. G. H. BOSWELL, F.R.S.

THE PRESERVATION OF SITES OF SCIENTIFIC INTEREST IN TOWN AND COUNTRY PLANNING.

THE study of the regional aspects of geography is intimately connected with the consideration of the safeguarding and appropriate preservation of sites and objects of scientific, historical and archæological importance and interest in the course of town and country planning. In 1924, Prof. J. L. Myres discussed the problem of the conservation of such sites and indicated four categories of objects worthy of preservation. In pursuance of the resolution passed at the Conference of Delegates, the Council summoned a meeting, the outcome of whose deliberation was that all learned societies should take concerted steps to promote legislation wider in scope and more strictly worded than the Ancient Monuments Act. Formerly the success of efforts directed to the preservation of sites and objects of scientific interest was due to the enthusiasm of advocates and the broadmindedness and public spirit of landowners and benefactors. While this work will, it is hoped, still continue, a large share of power is now in the hands of the people, who must possess sufficient knowledge as a requisite for useful action.

How can the British Association, and in particular the Corresponding Societies, inform the people and assist them to safeguard their national memorials?

The frequent references in the public press to this and cognate subjects indicate the people's awareness of the necessity and desirability for preserving sites and objects of scientific interest. The creating of public opinion must depend upon making known such objects and the information regarding all such sites is still incomplete. So far as Botany or Zoology is concerned no systematic attempt to compile a list was ever made in any country, but by the exertions of the Geological Society, a valuable list exists. If all the learned societies could co-operate in the preparation of a complete list of sites and objects of botanical, zoological, geological, historical and archæological interest, and communicate their results to the British Association, consideration of steps to be taken to secure legislative protection, will become easy and effective.

There are two aspects of preservation which might appear conflicting. Beauty spots and magnificent sceneries must always be accessible to the public and must be preserved from the encroaches of agriculture and industries. These are nature reserves. There may be a few spots possessing both scientific and æsthetic aspects, as for instance the area surrounding Downe in Kent, and when the Town and Country Planning Act is applied to this country, there is obviously a clear case that the planning should not be allowed to obscure the scientific and æsthetic interest associated with Darwin and Lord Avebury. The British Correlating Committee for the Protection of Nature submitted in evidence before the National Park Committee in 1929, a comprehensive list of areas where nature reserves are most required. In East Anglia there are a number of scenic types not exemplified elsewhere in Britain, and the whole place is littered by sites of such geological and archæological importance that the interest in the study of Pliocene and Pleistocene geology and in the records of pre-historic man has always attracted bands of students for study and research.

It may be recalled that in 1797, the discovery of palæolithic implements from Hoxne near the country boundary of Suffolk and Norfolk led to investigations revealing the great geological and archæological interest of the succession of ancient lake-deposits and early human industries, with the result that Hoxne has proved to be unique in Britain on account of the detailed evidence that it affords of inter-glacial climatic fluctuations. Another equally interesting place is the Gipping Valley-system north-west of Ipswich which has yielded a series of sub-crag rostro-carinate implements and flakes and a succession of human industries in the succession of glacial and post-glacial deposits. The Derby Road, which disclosed an inter-glacial lake-area similar to that at Hoxne is all but lost to Science.

Professor Boswell concludes the address with a significant observation that "Our duty as trustees for the future lies clear before us if only we adopt the view, that by acting now to safeguard sites of scientific interest, we are in effect taking steps to preserve some of the very title-deeds of our intellectual possessions."

Chemotherapy of Malaria.

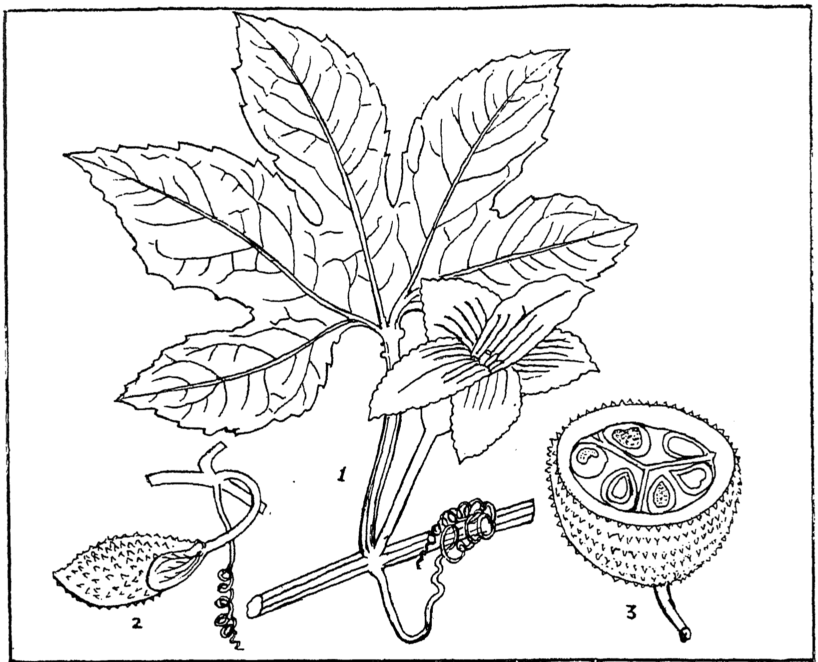
AT the recent session of the British Association, a discussion was held on the chemotherapy of malaria. Lt.-Col. S. P. James, F.R.S., in opening the discussion said, "The British Empire, with its vast malarious territories in the tropics, is more concerned with the provision of effective anti-malarial drugs than is any other nation in the world.

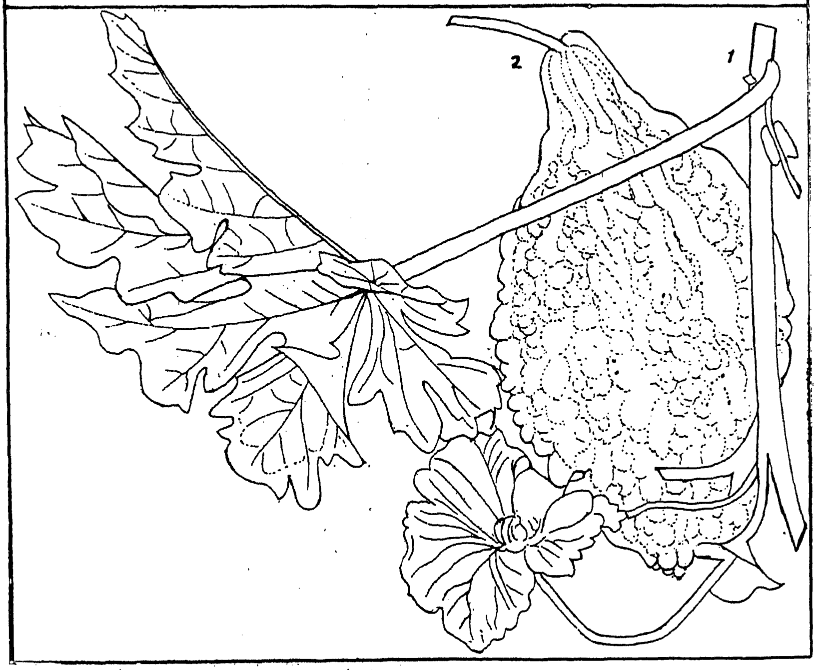
"Until recently the alkaloids of cinchona bark were the one and only effective remedy available. These natural products, however, are not effective for certain therapeutic purposes, particularly for true causal prophylaxis, the prevention of relapses and the prevention of spread. The aim of chemotherapy is to find preparations which will be effective for those purposes.

"Two remarkable synthetic anti-malarials, namely, plasmochin and atebrin, have been discovered and prepared on a large scale in Germany and their merits and defects for the particular purposes mentioned are now being assessed in the laboratory and in the field. Their discovery has given a great stimulus to chemotherapeutic work."

Lt.-Col. James gave an outline of methods and plans which are being tried or have been suggested for extending anti-malarial chemotherapy research in England, "where as yet it has been entirely neglected by the chemical industry and has received almost no financial assistance from Government or other sources."

Momordica cochinchinensis Spreng.





Momordica charantia Linn.

PLATE II.

the lime is deposited over a cellulose skeleton. This branched skeleton shows stratification of cellulose also when $CaCO_3$ is dissolved in dilute HCl (Fig. 5). As in the former species cystoliths occur in the lower epidermal cells which are much enlarged in size as usual.

In the cells of the basal hairs of *M. cochinchinensis* we also find deposit of calcium carbonate in a circular group (see Fig. 6). But here lime is not deposited on a skeletonic structure of cellulose and hence they are conveniently called pseudocystoliths. In the

other genus of Cucurbitaceæ similar deposit of lime in the leaves may be found—as for example, in the upper epidermal cells of the leaf of *Cephalandra indica* Naud, there is a considerable deposit of calcium carbonate. Such heavy deposits often impart dotted appearance on the leaf surface and give an impression of gland dotted structure (see Fig. 7). It seems that heavy quantity of lime (calcium carbonate) is deposited in these plants during the process of metabolism. According to Haberlandt[3] the deposit of calcium carbonate may be redissolved by the plant when the system demands it.

As mentioned before, lime in the form of calcium oxalate crystals is present in stems and petioles of Momordica (*M. charantia* and *M. cochinchinensis*). Most of the crystals are solitary. They are of rhombohedral types belonging to the monoclinic system (see Figs. 2, 3, 4, 6, (B), Plate I). Numerous other crystals of monoclinic system in the form of twin or clustered crystals are also deposited in the stem and petiole of these species (see Figs. 5, 8, 9, 10, (B), Plate I). Twin crystals (star-shaped) and combination of monoclinic and tetragonal system with crystals of other different structures making complex or composite forms have also been observed in the petiole of *M. charantia* (see Figs. 13, 15). Twin crystals are mostly present in the petiole, though a few may be found in the stem. The star crystals of *M. charantia* differ from those of *M. cochinchinensis* in having more projected and prominent star ends (compare Figs. 8 and 16). The crystals in *M. cochinchinensis* are less numerous and smaller in size than *M. charantia*. In both of these species the crystals are completely absent in the roots. In the stem they are more distinct and larger in dimensions. They are scattered everywhere in the ground-tissue and are absent in the epidermal cells and very scantily present in the vascular bundles.

If we trace the crystals of Momordica from the petiole to the leaf blade through the midrib we find that the size of the crystals is gradually reduced and thus the shape is not prominent, so much so that they are not distinguishable even under the higher power of a microscope, hence the term "dust crystals" are applied to them. Upto half of the midrib these crystalline dusts may be traced but beyond that they are invisible.

[3] Haberlandt, G., *Physiological Plant Anatomy*, 1924.

It is to be remembered that sufficient amount of calcium oxalate is manufactured in these plants as a product of metabolism. Prof. Haberlandt remarks that oxalic acid is formed in the plant body as the result of a variety of metabolic processes particularly in connection with protein synthesis but this substance is poisonous to the protoplasm and is accordingly rendered innocuous by combination with calcium to form the very insoluble oxalate of the metal; calcium must therefore be present in the plant in heavy quantity. According to some Plant Physiologists[4,5] calcium oxalate which is an excretory product may be redissolved by the plant when there is a deficiency of calcium food.

I am indebted to Mr. K. Biswas, Superintendent, Royal Botanic Garden, Calcutta, (Offg.), for favour of his kindly going through the paper and making valuable suggestions.

EXPLANATION OF FIGURES.

Plate I.

A. *Cystoliths from the leaf of* Momordica charantia (*regular shape*) *and* M. cochinchinensis (*irregular, heteroplanous and branched*).

FIG. 1. *Momordica charantia*—cystolith in groups of 3. × 280.

FIG. 2. *Momordica charantia*—cystolith in groups of 4. × 280.

FIG. 3. *M. cochinchinensis*—cystolith in groups of 3. × 232.

FIG. 4. *M. cochinchinensis*–cystolith in groups of 4. × 232.

FIG. 5. A double group of cystolith showing stratification of the cellulose skeleton after calcium oxalate is dissolved in dilute HCl. × 232.

FIG. 6. Pseudocystoliths in the basal cells of a hair of *M. cochinchinensis.* × 232.

FIG. 7. A calcified upper epidermal cell from the leaf of *Cephalandra indica,* the black dots indicate superficial deposit of calcium oxalate. × 232.

B. *Crystals from the leaf of* Momordica charantia *and* M. cochinchinensis. × 1000.

FIGS. 1-12 from *M. charantia.*

FIGS. 13-17 from *M. cochinchinensis.*

FIGS. 1, 5, 8, 9, 10—different forms of twin crystals (star-shaped) of *M. charantia.*

FIG. 13. Deposit of free calcium oxalate upon a crystal of tetragonal system.

FIG. 14. Formation of a star crystal on a tetragonal system.

FIG. 15. A group of crystals combined together.

FIG. 16. A star crystal from *M. cochinchinensis*; mark the difference between Figs. 8 and 16.

Plate II.

Momordica cochinchinensis Spreng.

FIG. 1. A flowering branch. × ½ n. size.

FIG. 2. A young fruit with a tendril. × ⅓ n. size.

FIG. 3. A T. S. of a fruit. × ¼ n. size.

Momordica charantia Linn.

FIG. 1. A flowering branch. × n. size.

FIG. 2. A fruit. × n. size.

[4] Dana, E. S., *Text-Book of Mineralogy*, 1905.

[5] Solereder, H., *Systematic Anatomy of the Dicotyledons*, Vols. I and II, 1908.

Chimera in Pineapple.

By I. A. Sayed, B.Ag.
Government Farm, Kumta.

A PINEAPPLE plant exhibiting the combined characters of the two varieties, *viz.*, Queen and Kew (Smooth Cayenne) grown on the Kumta Farm (North Kanara) was observed recently growing in a plot. A critical study of the same was undertaken with a view to differentiate the outstanding characters and ultimately determine its possible origin. The following are the most important distinguishing characters in which the plant was found to differ prominently from the existing two types.

The leaf margins like the Queen are armed with conspicuous spines but the surface resembles very closely the leaf surface of the Kew which has a distinct brown centre along its entire length with green edges. The leaf surface of the Queen, however, has a uniform reddish brown colour to about half the length, the base being greenish. The leaf margins of the Kew are perfectly smooth.

The tendency of the chimeric plant towards the production of 'seed' (planting material) has been found to be similar to that of the Kew which is a very shy bearer of suckers and more so of slips. The Kew variety produces on an average two suckers but instances of plant producing slips are very few and far between. The Queen pine, on the other hand, bears suckers and slips freely, often profusely; the average being four and five respectively.

The fruit and the crown consisting of cluster of leaves resemble very closely the fruit and the crown of the Kew, particularly in the colour of the 'eyes' which is deep purple. The contrast lies in the crown leaves, the margins of which are spiny like the Queen. It may be pointed out here that at the final stage of ripening of the fruit, all the 'eyes' not only showed a perceptible increase in dimensions but had completely flattened thereby giving the fruit a striking resemblance to the fruit of the Kew.

The foregoing distinguishing characters of the plant lead to the conclusion that the exposition of the plant in the present form is mainly due to the combination of characters of two distinct varieties and, therefore, it is difficult to determine its right origin.

However, the only possible explanation of this phenomenon is that the present chimera seems to have arisen from the Queen so far as vegetative characters are concerned, while the fruit gives a clear indication of its source from the Kew. And, since these have combined in a bud sport, it is reasonable to presume that the two types, *viz.*, Queen and Kew, must have arisen from a common stalk retaining the potentiality to mutate in either direction, *i.e.*, towards Queen or Kew when conditions were favourable.

Man and Woman.*

THE recent work of Havelock Ellis, *Man and Woman* which ostensibly sets forth to examine the leading characteristics of man and woman from the biological standpoint, provides an admirable background for the exposition of socio-economic problems. The fundamental point on which the main thesis is developed is that it is possible to regard the determination of sex as independent of any possible intervention by sex chromosomes, and also to recognise an essential sameness of sex in all organisms, the sexes being due to the action of two opposed sets of influences, one tending to produce the characters called female, the other tending to produce the characters called male. Apart from the physical structural differences, men and women usually display traces of dispositions belonging to the opposite sex, while it is not uncommon that the play of these traits may result in a physically homosexual condition. This conception of men and women underlies the doctrine of the entire equivalence of the sexes; and the investigation of the secondary and tertiary sex characters tends to point out that the unequal and unlike values are, in all their differences, of equivalent weight. Secondary sexual characters, supposed to be the product of sexual

*"Man and Woman". A Study of Secondary and Tertiary Sexual Characters. By Havelock Ellis. (Eighth Edition, Revised.) [William Heinmann (Medical Books) Ltd., London, 1934.] Pp. vi+469. Price 10*s*. 6*d*. net.

selection, are those obvious characters which render the sexes attractive to each other, while the tertiary characters which are not usually so obvious, and which may not be confined to only one sex, are generally predominant in one sex, such as height, stature, the structure of internal organs and the differences of endo-skeleton. There is a complete review of the anatomical features and physiological differences of man and woman, based on the conclusions deduced from scientific and statistical investigations, and the mass of information contained in the twelve chapters devoted to the treatment of the subject is simply prodigious.

The present knowledge of men and women can only tell us what they are under the influence of civilisation, but cannot tell us what they might be or what they ought to be; and even a precise knowledge of the degree of their modifiability will not enable us to limit the respective spheres of men and women. Men are more variable and women are more precocious involving greater rapidity of growth and its early arrest; these facts have consequences of wide significance. The whole physical and psychic organism of the average woman is unlike that of the average man, on account of this fact alone. Another fact of equally far-reaching character is that the average man diverges to a greater extent from the child-type than the adult woman. It may almost appear paradoxical to state that the growth of man, from about the third year onwards, is to some extent growth in degeneration and senility, through an absolutely necessary adaptation to environment, and that the human infant presents in an exaggerated form the distinctive characteristics of humanity, *viz.*, the large head and brain, the small face, the hairlessness, delicate bony system and enlarged endocrine glands. In many respects women remain somewhat nearer to children than to men, to that extent they occupy a higher scale in the line of evolution.

The facts of physical and psychical organisation of women have a profound practical bearing on the spheres of activity into which they are entering in increasing numbers. They are an important industrial factor, although a large portion of them may not remain as life-workers. Apparently, as a sex, they seem to lack both a man's ambition and his disinterested mental curiosity. Because of the possible transitoriness of their engagements, it is difficult to estimate the force and soundness of their disposition to be trained for skilled and responsible positions. At present, it is only in Scandinavia that women as a sex seem to be demonstrating any aptitude for the more skilled branches of technical work and obtain employment on equal terms with men. This is largely due to the fact that the economy of reproduction under improved conditions has given greater freedom to women and conferred on them a greater control of their own energies. The activities of men and women in all gainful occupations are bound to become competitive and their harmonious and wholesome relationship must depend in all such adaptations upon the preservation of the fundamental and natural constitution of each sex. The doctrine of the equality of the sexes led to unregulated industrialism, with consequences most injurious to women as is reflected in the condition of the physical and mental health of women labourers.

It seems fairly certain that women are not going to outstrip men or even to equal them, in the fields in which men are certainly successful. It is only in one country that they seem to be rising to the most responsible type of position and that country presents conditions both unusual and abnormal—Russia.

We have read this book with great pleasure. The interest of the book extends far beyond the limits of biological implications of sex. The study of secondary and tertiary sexual characters opens a new field of investigation of the social and economic problems, and their readjustment and final solution should not be subordinated to political doctrines.

The book is a profound philosophical treatise on the most fundamental human problem in its varied and complex aspects, and the clarity of vision, scholarship and above all the total absence of prejudice and conventional formulas which distinguish its pages are a contrast to the common-place literature on the subject of sex. Havelock Ellis is a wise thinker and his outlook may even be conservative, but his contributions to contemporary thought on psycho-physical subjects are marked by deep sympathy and wise scholarship. His *Man and Woman* is undoubtedly a great work and students of Anthropology, Sociology, Economics and Politics will find in it a wealth of information such as few books can provide.

Research Notes.

The Zeroes of the Riemann Zeta-Function.

RIEMANN conjectured that all the complex zeroes of $\zeta(s)=\sum_{n=1}^{\infty}\frac{1}{n^s}$ where $s=\sigma+i\,t$ lie on the line $\sigma=\frac{1}{2}$. No one has proved, till now, that the above famous conjecture is either correct or false. Extensive calculations of numerical kind have, however, shown that the conjecture is true for t lying between 0 and 300 and that the function has 138 zeroes in the above interval. Recently, Dr. E. C. Titchmarsh [*Proc. Roy. Soc.* (*A*), 1935, **151**, 234] has extended the numerical calculations by developing suitable formulæ and has found that the Riemann conjecture is true for t lying between 0 and 390 and that all the zeroes in the above interval, 195 in number, lie on the critical line $\sigma=\frac{1}{2}$. He has also presented some theoretical considerations on the problem of the zeroes.

N. S. N.

Combined Influence of Electric and Magnetic Fields on the Line Spectrum of Helium.

THE effect of crossed electric and magnetic fields on the line spectrum of Helium observed by W. Steubing (*Sitzb. d. kgl. Preuss. Akad. d. Wiss.*, 1935, pp. 1–16) has already been described in these columns (*Curr. Sci.*, 1935, **4**, 114). We may now notice the effect of coaxial electric and magnetic fields. There are a number of alterations in this case also, but the broadening of the Stark effect components does not occur. The Zeeman effect and an alteration of the intensities of the Stark components are observed.

I. Doublet separation is found only in s-components while the p-components (see III however) remain sharp and unaltered.

II. The sharp series shows a sharp Zeeman effect. The principal series is midway between the sharp and diffuse series in its behaviour.

III. In the diffuse series we have the null component (p and s) due to the magnetic field as a new line in place of the intense Stark effect pattern, and here the s-component becomes a doublet. The actual Stark components are present in the higher series members with low intensity, but their positions and relative intensities are as in the normal Stark effect, but the s-components all become double. The combination lines produced by the electric field vanish.

IV. With an electric field of 45,000 v./cm. and a magnetic field of 20,000 Oersted only the strongest Stark components of the diffuse series are faintly present. But with a magnetic field of 10,000 Oersted, the null line, which is very strong in the above case, vanishes while the normal Stark effect components are present.

The alterations in intensity are less important than in the case of crossed fields.

T. S. S.

The Relation between Atomic and Cosmic Constants in the Expanding Universe.

IT is now well known how Eddington has tried to bring about a relation between the dimensions of the atom and of the Universe in his theory of the fine structure constant. H. Ertel in the *Sitzb. d. Preuss. Akad. d. Wiss.*, 1935, deduces a relation between Einstein's cosmological constant λ, Newton's gravitation constant denoted by the author by the letter f, the proton mass m_+, the electron mass m, which is as follows:—

$$\frac{f\,m_+^2\,mc}{\pi h e^2}=\pm\sqrt{\lambda}$$

where c is the velocity of light, h is Planck's constant and e is the electronic charge. This result is deduced from Einstein's cosmological field equations and Friedman's differential equations which represent Lemaitre's theory of the Expanding Universe, together with a generalization of an equation given by Eddington.

If l_p and l_e are the de Broglie wavelengths of the proton and the electron ($=\frac{h}{m_+c}$ and $\frac{h}{mc}$) respectively, the above equation can be written in the more symmetric form

$$f\,\frac{m_+m}{e^2}=\pm\,\pi l_p\sqrt{\lambda}$$

$$f\,\frac{m_+^2}{e^2}=\pm\,\pi l_e\sqrt{\lambda}$$

With the numerical values $h=6\cdot547\times10^{-27}$ erg sec., $c=2\cdot998\times10^{10}$ cm./sec., $e=4\cdot770\times10^{-10}$ e.s.u., $m=9\cdot00\times10^{-28}$ grm. $m_+=1\cdot662\times10^{-24}$ grm., $m_+/m=1847$ and $f=6\cdot65\times10^{-8}$ dyne cm.^{2}/grm.^{2}, $\frac{1}{R}\frac{dR}{dt}=a$ (the Hubble factor) is calculated on the basis of the above theory to be $1\cdot812\times10^{-17}$ sec.$^{-1}$ while the experimental value is $1\cdot811\times10^{-17}$

sec.$^{-1}$ with an uncertainty of 20%. a is connected with λ by the equation

$$\frac{1}{R_0^{\,2}} + \left(\frac{a_0}{c}\right)^2 = \lambda = 3\left(\frac{a_\infty}{c}\right)^2$$

where R_0 = the equilibrium radius of the Universe and a_0 and a_∞ are the values of a for R tending to 0 and ∞. The theory gives $a_0 = 1 \cdot 134 \times 10^{-17}$ sec.$^{-1}$ and $a_\infty = 1 \cdot 833 \times 10^{-17}$ sec.$^{-1}$.

T. S. S.

Passivity of Gold.

THE resistance of gold to ordinary reagents and atmospheric influences has been traced to the formation of an adherent film of oxide on its surface. On the other hand, the anodic passivity of gold has been a matter of some controversy. Müller and Löw (*Trans. Far. Soc.*, 1935, **31**, 1291) have extended their "Surface Layer Theory" (Bedeckungstheorie) of passivity for gold electrodes. They have examined gold electrodes, under a reflection-polarisation microscope, when subjected to electrolysis in hydrochloric acid, taking care to protect the electrodes from convection currents. Simultaneous measurements of the current density have also been made. The surface at first appears dark under crossed nicols, and after a certain interval of time during which the current passes, it becomes bright. Corresponding to this latter stage when the current density falls, a diffuse layer of crystalline deposit is observed. The results show that gold exposed to air becomes coated with an oxide layer which is removed during anodic passivation in concentrated hydrochloric acid. An adherent film of the metallic salt now takes the place of the oxide layer. Discharge of OH^- ions at the anode can give rise to a 'secondary' oxide film. When the solution is well stirred the film of the metallic salt is easily disturbed. The natural oxide coating on gold is very stable and dissolves only in strong (5N) hydrochloric acid. The 'secondary' layer produced during anodic passivation is much less stable and disappears quickly even in dilute acids. In 5N hydrochloric acid, the 'secondary' layer formed, is dissolved out even during the passage of the current. The oscillations in current density when electrolysis is carried out are due to the alternate formation and dissolution of the film. The work of Müller and his co-worker brings out the close analogy between the behaviour of gold and of other metals less 'noble'.

M. P. V.

The Effect of Magnesium Deficiency on Crop Plants.

THE response of various crops to a deficiency of magnesium in the soil is described as the result of experiments conducted at the Massachusetts Agricultural Experimental Station by A. B. Beaumont and M. E. Snell (*J. Agri. Res.*, 1935, **50**, No. 6). Plants sensitive to magnesium deficiency developed characteristic physiological symptoms which have value in diagnosis. Chlorosis of the older leaves developed in the intravascular tissue. In the leaves with parallel veins this produced a striped appearance while in plants with a netted venation, a mottled pattern was produced. Curling of the leaf margins and marked necrotic areas also appeared in certain plants. Buckwheat and spinach were most affected, and turnips, mangels, corn and tobacco considerably so. The small grains, grasses, clovers and potatoes were only slightly affected. The addition of magnesium sulphate to the soil increased the percentage of magnesium in the plant or portions of it, the increase being greatest in the plants which were most affected in yield or appearance by a magnesium deficiency. It appears that to avoid magnesium deficiency a soil should contain from 30 to 40 parts per million of easily replaceable magnesium or 60 to 80 pounds per acre.

A. K. Y.

Pollination Studies in Toria and Sarson.

CROP improvement work relating to the two most important oil seeds of the Punjab *viz.*, Toria (*Brassica napus* L. var. Dichotoma Prain), and Sarson (*Brassica campestris* L. var. Sarson Prain) with particular reference to the special features of their pollination undertaken at the Lyallpur Agricultural College by Ali Muhammad is described (*Indian J. of Agr. Res.*, 1935, **5**, Part II). In both crops, cross fertilisation appears to be the usual method in nature chiefly through insect agency. Attempts at selfing under bags yield very poor results; in the six years' trials on the average only 12·3 and 20·3 per cent. respectively formed pods and many of these were not normally developed. The high self-sterility is surmised to be due not to external causes alone but internal causes also such as self-incompatibility. The explanation is suggested that the self-pollen is subject to an inhibiting action by the stylar tissue which makes it of slower growth than foreign pollen. The

observations also indicate that the inhibiting action is not equally effective in flowers of different ages, the secretion responsible for the action being produced actively between one to two days before and after flowering. Inbreeding and pure lines being thus of no economic value, group breeding has been resorted to and considerable improvement is reported to have been achieved already by mass-selection. It is stated as the result of hybridisation studies that self-fertility behaves as an inhibited character independent of the colour of the seed and that self-compatible brown seed plants have been evolved.

A. K. Y.

Spiral Structure of Chromosomes.

IN three papers of the July number of the *Proceedings of the Royal Society*, London, C. D. Darlington has described the detailed spiral structure of chromosomes in the several species of Fritillaria, and has deduced certain generalisations regarding the internal mechanics of chromosomes. The first paper [*Proc. Roy. Soc. Lond.*, (B), No. 807, 33], may be regarded as the general part where the broad features of spiral structure are described. The meiotic chromosomes possess both the major and the minor spirals and the first meiotic telophase, the major spirals relax to form relic spirals and by further expanding their loops form superspirals. The minor spiral does not relax. In the ensuing prophase the chromosomes contract and the relic and super-spirals disappear. The second metaphase chromosomes show similar spiral structures. During somatic mitosis only the minor spirals are present. The metaphase chromosomes show the threads very compactly coiled, while during the resting stage and during the later stage the threads divide. The nuclear cycle in mitosis shows that older coils are generally uncoiled externally while new coils are formed internally. In this respect prophase is a continuation of telophase and not a reversal of it as is usually supposed. The usual interpretation of the split nature of the metaphase and telophase chromonema are regarded as inconsistent with the spiral structure and with genetic and cytogenetic data. Several general assumptions have been made the chief of which are that the spiral arrangement is determined by a compensating molecular change, that there is a hysteresis or lag in the adjustment of the external form of the chromosomes to its internal molecular stresses and that paired chromosomes and chromatids on this account develop a "relational coiling".

In the second paper [*Proc. Roy. Soc. Lond.*, (B), No. 807, 59] a special study of the meiotic pairing in Fritillaria has been made. Pairing in this genus is incomplete and is liable to fail in parts attached to the nucleolus and the unpaired parts become relationally coiled. In fifteen species, pairing is interrupted very early and is therefore confined to the proximal regions. This leads to the localisation of chiasmata. The interruption of pairing is presumed to be due to the division of unpaired parts.

In the third paper [*Proc. Roy. Soc. Lond.*, (B), No. 807, 74] the relationship between chiasmata and the relational spiral is dealt with in detail. Three species of Fritillaria, *F. Elwesii* with intermediate localisation, *F. Meleagris* with extreme localisation, and *F. impirialis* with free distribution, have been studied. In the first two species the pairing is incomplete while in the last one it is nearly complete. Chromosomes remain associated at diplotene stages by chiasmata in the paired regions and by relational coiling in the intercalary unpaired regions. This can be understood if it is presumed that coiling occurs throughout the chromosomes but is replaced by chiasmata in the paired regions. In most organisms this replacement is nearly complete, but in diploid organisms with localised chiasmata and in triploids, coiling survives.

Dominance in Poultry.

A PRELIMINARY report of experiments of R. A. Fisher intended to throw light on the nature of dominance observed in certain well-marked breed characteristics in domestic poultry has recently been published [*Phil. Trans. Roy. Soc.*, 1935, **225** (B), 195]. The paper gives detailed data for the three factors responsible for crest, polydactyly and barred plumage.

The belief of Darwin and earlier writers that hernia was connected with the crest was abandoned by geneticists early in the 20th century on inadequate evidence but from his experimental data he has been able to conform completely with the view that crest and hernia are due to the same gene. This view also explains other significant features in the data; notably the complete absence of grown birds showing hernia without crest and the linkage relations with the Polish comb and with Pile.

Polydactyly when introduced into the wild jungle fowl is a typical example of the mutations with intermediate heterozygotes in which dominance is absent. The heterozygote is distinctly variable and occasionally overlaps the normal homozygote.

Barred plumage is more nearly a recessive than a dominant mutation; the heterozygous males are more like the wild than like the barred homozygotes. The barred hen when young is indistinguishable from the heterozygous male. The barred mutation thus introduces a sexual differentiation and when this sexual differentiation does not exist barred may be described as a dominant.

The three factors reported in this paper bear out the suggestions that the supposed "dominants" found in domesticated breeds of poultry show distinct lack of dominance when introduced singly into a wild strain. Any dominance shown by them in breed crosses must be due to modification during the period of domestication.

The Development of the Vertebral Column in the Haddock (*Gadus æglifinus*),

IN this contribution to our knowledge, a set of new observations is made on the vertebral column of the Haddock by A. J. Faruqi (*Proc. Zool. Soc. Lond.*, Part II, 1935, 21). The perichordal sheath forms the centrum of the vertebra in *Gadus* unlike in *Herring* where the notochordal sheath participates in it. The basi-occipital region is a composite structure incorporating in it an 'intercalary' neural arch. As opposed to the tetrapoda, the posterior zygapophyses take their origin from the centrum itself. Confirming the observations of Stannius, it is noted that the spinal ganglia in the trunk region become divided into two,—an upper accessory ganglion and a lower spinal ganglion and these two are connected together by a commissure.

On the Post-Embryonic Development of the Respiratory System of *Dialeurodes dissimilis* (*Homoptera, Aleurodidæ*).

BESIDES Fuller's pioneer work on the post-embryonal development of the tracheal system of termites, not much work has been done on this important problem. M. L. Roonwal gives us an account of the post-embryonic development of respiratory system in *Dialeurodes* (*Quart. J. Micr. Sci.*, 1935, **77**, Part IV, 605). The author points out that the number of spiracles in the nymphal instars is 4 and the tracheal system consists of paired ventral- and dorsal-longitudinal trunks. Tree-like branches arise some of which of course atrophy,—the final number being 156.

Larval Stages of Trilobites from the Middle Cambrian of Alabama.

C. G. LALICKER'S (*Jour. of Palæo.*, **9**, No. 5) observations on the Trilobite Fossils from Alabama show a series of changes in the larvæ specially in the "protaspis stage" not noticed hitherto—the most important being the appearance of eyes later than the facial suture, palpebral lobes and free cheeks on the dorsal side—instead of migrating from over the margin from the ventral side, as formerly suggested. This "spontaneous generation" of the eyes on the free cheeks seems to develop during some critical moult which takes place in some trilobites earlier than in others. Secondly, the migration of free cheeks from an early anterior position to a late lateral position indicates that during the protaspid stages the cephalon is of the proparial type, whereas it becomes opisthoparial in the meraspid and holaspid periods. These observations suggest that the appearance of eyes in a later stage was in the nature of an "adaptational control" as a result of the existence of both larvæ and adults under aphotic or nearly aphotic conditions.

C. P. K.

Paleozoic Foraminifera, their Relationships to Modern Faunas and to their Environment.

OUR knowledge about paleozoic foraminifera was usually confined to the study of fusulinids. Improved technique and intensive collection in recent times have revealed a large foraminiferal fauna throughout the paleozoic. The development of the group indicates that the earliest types had chitinous tests. During the next stage there was attachment of various foreign particles to the chitinous test. The upper cambrian form—Spirillina—indicates that the earliest foraminifera were tubular and consisted of an early proloculum. Later on the foraminifera developed an elongate undivided chamber often coiled about itself in one plane. Foraminifera with calcareous tests have not been reported till carboniferous times and this suggests that the primitive forms were predominantly arenaceous. At present the arenaceous forms occur in various habitats but most commonly in waters of

medium depth in temperate regions. In waters where calcareous materials are abundant, the chitinous cement which would hold the foreign particles on the test would be converted to calcareous substance thus giving rise to calcareous tests. From these observations J. A. Cushman (*Jour. of Palæo.*, **9**, No. 3) suggests that calcareous foraminifera developed later and had a limited habitat.

C. P. K.

The Yeravas of Coorg.

By Rao Bahadur L. K. Ananta Krishna Iyer.

Introduction.—The *Yeravas* are the aborigines of Wynad, one of the taluks of South Malabar, from which they gradually spread to the forests of South Coorg. They are rarely found in the northern division. They are the lowest of the jungle tribes of Coorg. They appear to have been, from a remote period, in a servile relation to the *Betta* Kurumbas. They are now scattered all over the villages of the two *Nads* of Ponnampet and Srimangala.

Internal Structure of the Tribe and Habitat.—There are four endogamous groups, *viz.*, the *Panjiri*, the *Pania*, the *Badava*, and the *Kagi* Yeravas or *Karatte*. The *Panjiri* stand highest in the social scale, and the *Kagi*, the lowest, because of their habit of eating crows (*Kan Kagi*). The *Panjiri* Yeravas are divided into two sub-groups, *viz.*, *Ippumale* Yeravas and *Karatti* Yeravas. The former are said to have immigrated from *Ippumale*, which is situated beyond the Manantoddi river; and are generally found in Srimangala and Ponnampet Nads; and the latter in *Karattimale*, near Bythor. Though they belong to one and the same group, yet there is no intermarriage between them. *Panjiri* Yeravas have come from Mysore. The *Badava* Yeravas who are mostly found in Mysore near Heggadadevanakote, are rarely met with in Coorg. There is no interdining and intermarriage between these two classes. There is also not much difference between the *Pania* and *Karatti* on the one side, *Panjiri* and *Badava* on the other. The *Panias* and *Panjiries* neither interdine nor intermarry. A *Panjiri* can become a *Pania* but not *vice versa*.

Habitations.—The Yeravas live in thatched huts. The walls are made of bamboo reapers, interwoven and plastered with mud. They never build a house with mud walls because of their migratory habits. Frequently they run away without provocation from their old masters to some distant places in the forest and on settling down under another landlord, they proceed to build a fresh hut. Their dwelling places generally have a veranda of about 10 feet square. Walls are half built all round. Their fire-place is on one side. They have a small pit to pound paddy in. Their domestic vessels are mostly earthen pots and dishes. The latter are used for taking food. They rarely use copper or brass vessels. Before the occupation of a newly built house, the Yerava worships *Kuttathamma*, their chief deity and *Gulikan* (a demon) with offerings of rice, cocoanut, toddy, banana and fowl, with the prayer, "O! Ye Divine Beings, by your grace we have built this hut; keep watch and ward over us and our family."

Betrothal.—Cross-cousin marriage is in vogue amongst them. The Yeravas avoid all relations on the father and the mother's side. The Yerava adults have no voice in the choice of a maid for wife. It is generally their parents who negotiate for the marriage of their sons. When a young man has reached the marriageable age, and a suitable girl is found, his parents and the headman of the tribe* (*Kanalādi*) take the *tāli* or marriage badge, a *sādi*, and all the articles necessary for their food to the hut of the bride-elect. They prepare the food, light an oil lamp filled with cocoanut oil and offer sacrifice to their gods, *Kuttathamma* and *Gulikan* along with cocoanut and banana. Some rice also is placed in a sieve. The maid's *Kanalādi* asks them the object of their visit. The young man's *Kanalādi* replies that they have come to propose the marriage of their daughter to the young man. The girl and the young man's names are also given. Then, the bride's *Kanalādi* says in the presence of the gods and those assembled, that they are prepared to give the maid in marriage to the young man. She is brought to the presence of the parties assembled. They then pray to their gods to help them in the celebration of the marriage. The *Kanalādi* of the bridegroom-elect ties the *tāli* round the girl's neck, and gives the *sādi* to her with one *hana* (three annas). The parties sit together and partake of the food already cooked. The maid's *Kanalādi* fixes the date of marriage (*Mangala Kurippu*). Generally the betrothal takes place a month before the marriage, to the celebration of which the *Kanalādis* on both sides must consent. If the bride's party cancels the betrothal, they have to pay the expenditure incurred by the parents of the bridegroom-elect. If the fault is due to the indifference or neglect of the bridegroom's party they should forfeit everything given to the bride-elect.

Marriage Ceremonies.—On an auspicious day before the celebration of the marriage, the relatives of the bride and bridegroom assemble in the respective families. *Chapras* are erected with ten or twelve poles in front of the houses of both the bride and bridegroom. Pigs or fowls are slaughtered. Ancestors are worshipped. Parties assembled are treated to a feast. The night is spent merrily by the beat of drum and the tuning of pipes for dancing. On the day of marriage the young man is bathed, neatly dressed and adorned, and is conducted to the marriage in procession. He is seated on a tripod a foot high. A lamp is lit before him. His mother and other married women throw rice on him as a token of blessings, and give him a present of a few

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*The name *Kanalādi* in Wynad and Coorg is applied to a class of men who act as "Oracles", "Fire-walkers" and "Devil-dancers".

annas. Then follow others, after which the members assembled there are sumptuously entertained. In the evening the bridegroom's party start in procession to the family of the bride-elect so as to reach it before day-break. They halt near the residence of the bride-elect. The bride's party welcome them with light refreshments and toddy. They are conducted to the marriage booth in front of the hut of the bride-elect. As the bridegroom-elect enters the booth, an elderly woman of the family washes his feet, for which one hana is paid to her service. He is then seated on a tripod. All the gods of both parties are served with parched rice, cocoanut and bananas. The bride and bridegroom are asked to stand together, and the gods are invoked to witness the ceremony and to bless them when the assembled guests throw rice and give them presents, varying from three pies to three annas. The *Kanalādi* asks the bridegroom to grasp the hand of the bride. The guests assembled there are treated to a feast, after which the bridegroom and his party with the bride return to his hut. Just then the bride's mother or some elderly woman stands at the gate, when the bridegroom gives her eight annas and requests her permission to take the girl. In the family of the bridegroom the same formalities are gone through. The bride touches the feet of everybody as a sign of obedience and respect to the elderly members who give some presents of coins which become her pocket-money. The *Kanalādi* comes on the fourth day. The bride is bathed, dressed and adorned in her best. She performs the *Gangapuja* and brings water to the hut in a few pots. She is then dressed in a new *sādi*. After a sumptuous meal the guests disperse. There is no special ceremony for consummation which takes place in the bridegroom's hut after his return with the bride. The married couple again go to the bride's family, stay there for a few days and then with the bride return home. Thereafter they live as husband and wife.

If the parents are unable to meet the expense of the ceremony, they connive at the young persons making friends, and the girl one day elopes with the young man, and remains in the forest for a few days, and then the girl returns to her hut. She is not allowed to enter it. Her parents inform the villagers who assemble to enquire into the matter. The *Kanalādi* comes. The couple confess their guilt, and pay a fine of a rupee or two, when they are condoned. The *tāli*-tying takes place. They become husband and wife. These formalities cost five rupees, while the marriage ceremony requires twenty-five rupees. A man can have more than one wife. The first wife has no special privileges. Concubinage is also allowed. Widow marriage is in vogue amongst them. On the day fixed for the marriage ceremony the man goes to her hut with his friends and relatives, invokes his gods for blessings, and ties a *tāli* round her neck, and gives her three annas. Thereafter they become husband and wife.

Adultery and Divorce.—Adultery and divorce are current among them. When a woman commits adultery with a man, and when that is known, a meeting of the tribesmen is called for to enquire into the matter. When it is proved the delinquent has to pay a fine of one to ten rupees. Sometimes he is compelled to marry her after payment of the marriage expenses for which he is responsible. A man can divorce his wife at his will and pleasure, when he simply takes her to her parents and says that he does not want her. This is the ordinary form of procedure. Sometimes the husband in a fit of provocation sends her out of the house, saying that he does not want her, and that she can go where she likes.

Pregnancy.—When a woman is pregnant her parents visit her during the seventh month, give her sweets and stay with her for a day or two, and then take her to their hut.

Delivery and Child-birth.—The Yeravas put up a temporary hut for the delivery and confinement of their women. When a woman suffers from pains of child-birth an elderly woman of the family—usually her mother—acts as her nurse. Soon after delivery, the mother and the baby are bathed in warm water, and this is continued during the period of uncleanliness. Soon after delivery, she is given a decoction of cumin seeds, ginger, asafœtida, and fed with rice *kanji*. The pollution is for eleven days and she bathes on the twelfth, when the naming, feeding, and cradling formalities are gone through. She continues to be in a state of uncleanliness for a period of forty days.

Family.—Family is patriarchal. In the absence of children to a man, he can adopt a boy, below twelve years of age. The *Kanalādi* comes and the boy is bathed and dressed in new clothes. Their gods are worshipped with offerings of rice puddings, cocoanuts and bananas. The *Kanalādi* holds the boy's hands and says that henceforth he is the son of so and so; "let the gods who are invoked bear witness". He hands over the boy to the person who adopts.

Every adult member of the family should work and earn his daily bread, unless he or she is sick, old and infirm. Not even one per cent. of the Yerava population owns lands. They are all coolies. An Yerava will preserve nothing for the morrow. He wants everything fresh. The family—both husband and wife—goes to work, and each member gets food and paddy as wages. They bring the paddy, and the woman pounds only as much of the paddy as the family requires for the night's consumption. The man will sit near the fire or in the moonlight during the dry weather beating his drum and singing. The boys and girls dance, sometimes the woman also joins the dancing party. At the time of the harvest and on full moon days the drumming and dancing will last throughout the night. They never use a lamp in their huts. Often a Yerava feels reluctant to work. He does not care for the urgency of his master. He will quietly walk with his wife into the jungles in search of honey, fruits, roots or fish. Generally the wife cooks the food. But there is no objection if the husband joins her.

Tribal Organisation.—The villagers assemble together at a certain place once in a year, the main object of which is to offer prayers with sacrifice to the spirit of the dead. The meeting continues for three days. Every family has to bring rice, cocoanut, toddy, etc. First they enquire into and discuss about cases of adultery, divorce, elopement, etc., if any. The *Kanalādi* presides and decides such cases. Then the deities and the names of the dead are propitiated with rice

puddings, cocoanut, toddy and fowl. The *Kanalādi* performs the rites, sings songs in praise of the sanity and powers of the tribal deities *Kuttathamma*, *Gulikan*, *Kuttichathan*, and the dead heroes who have done great deeds such as killing tiger, driving away demons and other spirits. When this is over they eat and make merry. The Yeravas have their own pipes and drums, and bring as many sets as they can afford. Young men, women and children join together and dance in a circle to the piping and beating of drums. This continues day and night. It is chiefly in this "*Pandalata*" that women (other's wives) and grown-up girls are enticed away by men. They quietly slip away at night and seek their abodes in the forest for some days or go away to distant villages where they live as man and wife. Those who escape into the forest return in a day or two. The *Kanalādi* fines them, compensates the husband of the woman by payment of a few rupees. If the fine is not paid, the culprits will be expelled. Nobody dares to go against the judgment of the *Kanalādi*. His post is hereditary.

Sorcery and Witchcraft.—They believe in magic, sorcery and witchcraft like the jungle tribes. Spirits and Gods are believed to enter into the body of *Kanalādi* or some other person appointed by him. The spirit or the God will speak through the man, give information of the past and prophesy. They believe in the potency of evil eye. All kinds of disease are brought about by the evil spirits or demons, and the gods of the *Panchamas* to obviate which talismans, enchanted threads and certain beads are worn by them.

They practise sorcery. The sorcerer draws the picture of a demon with rice powder and to make it appear fearful to look at, he puts powders, coloured red and black, here and there, and keeps cocoanut oil lamps. Bamboo sticks about a cubit long are sharpened at one end pointed like a pencil. Clean cloth is tied at one end, and then it is dipped in the oil and lit. This is the lamp used on such occasions. Beaten rice, etc., on plantain leaves is kept at one side. The sick man is made to sit before the leaves. The sorcerer with coloured water in his hand begins to utter his incantations and finally kills a fowl, after sprinkling the water on it.

In case of exorcism by dance the sick man is made to sit in the centre, and is decorated with flowers and *kunkum*. The sorcerer and his subordinates beat their drums and dance round the man singing peculiar songs. Sometimes the sick man if he is believed to have been possessed by a spirit, is beaten with a cane. He then runs; the sorcerer takes him to a tank or river and makes him dive and come out. He (sorcerer) gives him new clothes to wear. The spirit is then supposed to have left him by this time.

Religion.—Their gods are *Kuttathamma* and *Kali* who are believed to reside in a place near Kutta, a small town between Coorg and Malabar. *Chāmundi* and *Kāveri Amma* are their chief deities.

The routine form of worship is as follows.—The *Kanalādi* keeps rice, cocoanut, etc., in a neat place, lights a cocoanut or a castor oil lamp and stands before it, facing the sun, and prays to God, requesting Him to grant what the worshippers want. They keep no image, but plant a rough stone under a tree to represent their *Gulikan*. At Kutta their chief Goddess *Karingali* or *Kuttathamma* is represented by a stone. They offer toddy, a fowl or two with prayers when they worship. They worship *Ganga* (water goddess) during marriage ceremonies. They observe all the Coorg festivals and those of the high class Hindus, namely,

1. *Makara Sankramana* in January.
2. *Sivaratri* in February.
3. *Gowri* and *Ganesa* in September.
4. *Kalimuhurta* in September (Coorg festival).
5. *Kaveri Sankramana* in October.
6. *Hutri* in November or December.

The Yeravas have a *Karingali* mutt in Wynad. Some go there as pilgrims. They fast during *Kuttathamma* festival in February. This festival lasts for seven days. They do not worship rocks or trees, but plant rough stones under a tree to represent their gods and demons.

The fields are believed to be haunted by devils, for which they offer sacrifice. The *Kanalādi* comes to Kutta during the *Karingali* festival. He is the final authority on all religious disputes and on matters connected therewith.

The Yeravas worship the Mother Earth, the river Cauvery, *Lakshmanathirtha* and other springs. Before commencing to dig a well they consult their priest and sometimes they sacrifice fowls and offer cocoanuts.

Funeral Customs.—The dead are generally buried. The dead body is washed and covered with a new white cloth. It is then covered with earth. Some rice and milk or if milk is not available, cocoanut water are poured into the pit. Some rice and water are also placed close by. On the eighth or tenth day the funeral ceremony is performed. They call it *Kake Pile* (bali) and keep food for the crows. The hut is smeared with cow dung. All bathe. The *Karanavans*—all the dead—are offered food, meat and toddy. The *Kanalādi* calls upon the God and the Sun to give a good place to the spirit of the dead, and protect the living members of the family. The closest relations keep the offerings outside the hut for the departed soul. If crows do not eat it at once, the members of the family think that there has been something wrong, and also infer that gods and the departed souls are angry with them. Often they perform the ceremony again on another day.

Occupation.—The chief occupation of the Yeravas is agriculture. They have no lands of their own, but work for wages. They select auspicious days for ploughing, sowing seeds, transplanting and reaping. They also know which rain is the best one for each crop, and some foretell by the commencement of the rain, the year's crop. They perform no ceremonies either at the beginning or at the end of the agricultural operations. But like other agricultural communities they worship the implements, bullocks and the like.

Prædial Slavery.—Prædial slavery in Coorg differed only in a few respects from that in the districts below the ghats. The members here were condemned to this state of servitude and were in a complete state of degradation. They belonged to three classes, one below the other; and all belonged to the lowest grade of society. Three to five members were owned by a proprietor of a small estate. Though they were not treated with severity, the general conditions of their

service subjected them to great hardships. They were rarely sold, but were frequently given as security for the money borrowed. This was the most general mode of transferring the usufruct, and one, above all others, likely to produce the greatest wretchedness. The mortgagee had the benefit of their services for the time being, and this was considered as equivalent to the interest for the sum advanced. They are now free. The state of prædial slavery here described is to some extent similar to that of the rural vassalage yet known in Poland and parts of Russia.

The prædial servants of the agriculturists were obliged to perform the work of the Circar. The servants of every ryot were at the disposal of the Circar, and their service given as a matter of right which was generally admitted. Each cultivator had to supply a certain number in proportion to his means, and the *Parputty* of the *Nad* was entrusted with all arrangements regarding them. Each Nad had to furnish a certain number of labourers for work. This requisition extended also to the Nads below the ghats. The body of labourers thus always collected was generally employed at the Capital, (Mercara), where works of some kind or other were constantly undertaken. No compensation was given to the owners of the servants thus employed ; because it was termed *Kwhee* or voluntary, and consequently the servants got no wages. They were fed by the Circar during the period of work. This system pressed hard on both masters and servants, particularly the latter, who felt and considered it a serious evil. There were numerous other instances in which labour was supplied to the Government without any remuneration.

Social Status.—The Yeravas avoid the food cooked or touched by the Muhammadans, Panchamas and others who eat beef. They eat food cooked by the members of the other castes.

Appearance, Dress and Ornaments.—The Yeravas are diminutive in stature. Their complexion is dark, and their whole appearance carries with it an air of wretchedness. Their garments consist of a loin cloth, and they wear no head gear. The hair is tied into a knot on the top of the head, which gives them a wild and savage aspect. Those who have observed them confirm that they possess the Negroid characteristics with thick lips and compressed nose, though both features have been considerably effaced. Their curly hair is very much softened by combing.

Conclusion.—The Yeravas have very much improved of late. Both men and women are hard working, and they are therefore in great demand in coffee estates. They are not reliable, and the contact with estate coolies and maistries has spoilt their simple habits and made them adepts in cunning and cheating. They often decamp from their bamboo huts in the jungle, and travel with kin unobserved in one night out of reach of the pursuer. They often run away with advances, and extend their wanderings to Wynad, and on their return they easily find new masters with little or no chance of discovery especially when employed in Coorg houses during the working season. They conform as much as practicable to the mode of life and worship of the Coorgs. Like the Kurumbas they are chiefly found in Kiggatnad and Yedalknad taluks.

Science Notes.

Some Observations on the Thermal Structure of Cumuliform Cloud:—R. G. Veryard (Indian Meteorological Department, Scientific Notes, Vol. VI, No. 61).—During 1932 and 1933, a number of observations were made at Peshawar, Kohat and Risalpur, in the N. W. F. P., of the temperatures (dry and wet bulb) inside and outside cumulus and cumuliform clouds. Although the readings cannot be accepted as reliable to within less than 1°F., they are interesting inasmuch as they confirm that the temperature inside cumuliform cloud may be higher or lower than the temperature of the surrounding air. An analysis of the results shows that (*a*) on thirteen out of the fourteen occasions when the cloud was observed to be dissolving, its temperature was mainly lower than that of the surrounding air, and (*b*) out of twenty occasions when the cloud was observed to be growing, its temperature was mainly higher than that of the surrounding air on ten occasions but mainly lower on six occasions. With regard to the question of supersaturation, the observations do not show convincingly that supersaturation occurs in cumuliform cloud.

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The Geological, Mining and Metallurgical Society of India.—At the 10th annual meeting held in August, the following were elected members of the Council for 1935-36:—

President: Prof. N. P. Gandhi. *Vice-Presidents*: Mr. P. Evans and Mr. J. K. Dholakia. *Joint Secretaries*: Mr. N. N. Chatterjee and Prof. S. K. Bose. *Treasurer*: Mr. S. L. Biswas. *Librarian*: Mr. B. N. Maitra. *Other Members of the Council*: Prof. M. Chatterjee, Dr. P. K. Ghosh, Mr. H. M. Lahiri, Mr. D. C. Nag, Mr. G. G. Narke, Mr. B. Rama Rao, Prof. S. K. Roy, and Mr. K. K. Sen Gupta.

In the course of his Presidential address, Mr. M. M. Mukherji dealt with the *Present Day Problem of the Indian Coal Industry.* The principal mining industry of India, *viz.*, the coal industry, is now practically on the verge of collapse. This is partly due to the economic depression and partly due to the very wide margin that exists between demand and the immediately available productive capacity. The latter is really more serious because the surplus productive capacity of the mines induces the owners to sell their coal at any price, which ultimately proves detrimental to the producers as a class.

The question is how to rescue this industry from the quagmire of depression ? The one immediate remedy suggested is the closing down of the Railway Collieries. Out of the total consumption, the Railways account for over ·34 per cent. Although it is true that at present the Railway collieries supply only a part of this, they possess potential possibilities for supplying the whole of the Railway requirements. Their closure will automatically restrict the output and cannot

fail to have a salutary effect on the industry. The Railway Authorities contend that the closure of the collieries would mean a recurring expenditure of 41 lakhs of rupees a year for maintaining them in good working condition. Mr. Mukherji suggests that the coal trade will not probably be unwilling to pay this amount, if Government would collect that sum by levying some cess on coal despatched as long as Government is not in a position to sell those collieries at a fair price.

Mr. Mukherji also dealt with the problem of metallurgical coke. This particularly valuable class of coal far from being conserved for use in industries, for which they are eminently suited, is being used for purposes where inferior grades would suffice. It has been estimated that for the years 1931 and 1932, of the total amount of coal mined in India suitable for the manufacture of metallurgical coke, only 13.9 and 14.7 per cent. respectively was used for the manufacture of hard coke. The Coal Fields Committee reported "that the Railways should be recommended to use more of inferior coals for shunting purposes in marshalling yards and that mills and other industrial consumers might also adjust a type of furnace specially designed for burning low grade fuel." The problem of conservation of metallurgical coal is of vital interest to the growth of the metallurgical industry in India.

The embargo placed on the export of coal in 1920, resulted in the "disappearance of Indian Coal for overseas market for the time being" and to recapture a lost market, strenuous efforts and Government's active assistance are needed. It is mentioned that India obtained in 1920 one and half crores of rupees by exporting coal, while in 1933, she realised only 41 lakhs through her exports.

* * *

International Commission of Agriculture.—The Commission held its general assembly at Brussels and Gumbloux (Belgium) under the chairmanship of the Marquis de Vogue (France), President. The assembly devoted special attention to the present condition of Agriculture, which appears to have grown worse in spite of the useful measures taken in certain countries. The two main problems which require solution are (1) the wheat problem, and (2) the edible fat problem. According to a report in *Nature*, the Commission resolved to hold its next meeting in 1936, in Oslo, and the twelfth International Congress will take place at The Hague in 1937.

* * *

Empire Meteorologists' Conference.—The third Conference of the Empire Meteorologists was held at South Kensington on August 12–21. The meetings provided an opportunity for Directors of Services to exchange views on diverse subjects. Considerable attention was devoted to meteorological arrangements necessary to meet the Government's requirements in connection with the Empire Air-Mail Service. A few problems arising in this connection are the making of synoptic charts on a uniform plan and the coding of reports from land stations and air-ships. Other subjects discussed concern meteorology for the Army and for the Navy, instruments, upper air observatories, marine meteorology, geophysics, climatology and agriculture and seasonal forecasting. In connection with geophysics, the Conference passed a resolution recommending the establishment of a station at Chesterfield Inlet, Hudson's Bay, Canada. This station would be in near proximity to the North Magnetic Pole and its situation would also be very favourable to auroral studies. The Conference also recommended the establishment of a station at Tristan la Cunha, observations from which, situated as it is, about midway between the Cape of Good Hope and South America, would be of great value. Regarding climatology and agriculture it was suggested that climatological data should be broadcasted. The outline of a scheme was proposed for broadcasting of brief data from related stations in each country on the fifteenth of the month following that to which the data refer.

Twenty-five dominions and colonies were represented at the Conference.—(From *Nature*, September 7, 1935).

* * *

The International Faculty of Science (Central Office: 85, Gloucester Place, London).—At the meeting of the Council and Executive Committee held on Wednesday last (September 4th, 1935), a resolution was unanimously carried "that Professor M. Sayeed-ud-Din be appointed a Vice-President of the Faculty for India, in the place of Professor Hunter, resigned".

* * *

Dr. Friedrich Levi has been appointed Hardinge Professor of Higher Mathematics, in the University of Calcutta. Dr. Levi was formerly extraordinary Professor of Mathematics at the University of Leipzig. The appointment is made for a period of five years.

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Sir Josiah Stamp, statistician and reputed economist, Chairman of the London Midland and Scottish Railway, has been elected President of the British Association for the Advancement of Science, 1936.

The British Association will meet at Blackpool next year from September 9 to 16, and will visit Nottingham in 1937, Cambridge in 1938, and Dundee in 1939. The 1940 meeting will be in Australia.

It is suggested that a select party of the British Association be sent in winter of 1937–38 to take part in the Jubilee Meeting of the Indian Science Congress.

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Mr. R. M. Statham has handed over charge to Sir George Anderson, as Education Commissioner to the Government of India.

* * *

Sir Richard Paget, Bart., recently announced at the International Congress of Phonetic Sciences that the most universal language is that of signs. Sir Richard has been comparing the sign-languages all over the world and he is of opinion that the sign-language is so fundamental and natural that uneducated deaf mutes from the Far East or African jungles can talk with English deaf mutes and make themselves understood.

* * *

Col. Gill, the Malaria Expert, who was specially appointed by the Government of Ceylon to investigate the causes of the epidemic in November last, has recently submitted his report to the Executive Committee of Health. The epidemic of 1934–35 which overtook that Island was of exceptional magnitude, and it is predicted that

for some decades to come an epidemic of that intensity will not occur. Another epidemic is however predicted in 1940. The last sweep accounted for over 38,000 deaths in three months, and forty lakhs of rupees have already been spent by the Government for relief measures, and a sum of fifteen lakhs of rupees has been provided in the new budget. It is understood that Col. Gill recommended the enactment of an anti-mosquito ordinance to arm Government and local authorities with powers to insist on tenants of houses and estate owners to carry out all reasonable anti-malarial measures. No special organisation for controlling malaria is called for, and the local malarial organisation should be sufficient to deal with the control measures.

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Fridera.—The causes leading to the premature failure of wooden sleepers in railways, is due to (1) mechanical abrasion, and (2) natural decay. The former is accentuated by the looseness of rail fastenings; this is otherwise called 'Spike-killing'. The chemical destruction of wood fibres at the rail seat also adds to the failure of wooden sleepers, thus rendering them unsuitable, long before they become useless through natural decay. At the request of the Railway Board, the Chemical Branch of the Forest Research Institute, Dehra Dun, undertook to evolve a composition which could be melted and poured into the worn-out spike holes, and the spikes then fixed into position; when cold the composition would set hard and have a firm grip both on the wood and the rail. The manipulation should be made *fool-proof* and the composition should have a sufficiently high fusion point to withstand the summer heat of India (temperatures up to 150° F.). A composition has been evolved and patented by Dr. S. Krishna under the name of *Fridera.* The holding power of the composition is excellent, requiring a load of 6,000–7,000 lbs. to pull out the spike, the untreated wood requiring 3,000–4,000 lbs. only. Trials have been made upon tracks and proved satisfactory. Tests conducted by Mr. V. D. Limaye at the Forest Products Laboratories, Canada, have shown that *Fridera* does not lose its grip at low temperatures, as low as −20° F. It has thus been demonstrated that *Fridera* retains firm grip both on metal and on wood under extreme variations of temperature.

The Forest Research Institute has also been responsible for developing and patenting an efficient wood preservative under the name *Ascu* (Patented by Mr. S. Kamesam) which increases the durability and life of wood, and makes possible the utilisation of sap woods and jungle woods for construction purposes (see *Curr. Sci.*, 1935, **4**, 89). It is thus possible to reduce considerably the heavy expenditure incurred in renewal of sleepers by (1) minimising mechanical abrasion by the use of *Fridera*, and (2) by prolonging the life of the wood by treatment with *Ascu.* (Extract from *Indian Forester*, 1935, **61**, 660.)

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In an interesting note published in *Nature* (September 7, 1935) Mrs. Barlow has, as a result of her examination of the unpublished Darwin manuscripts, brought out evidence to show that as early as September 1835 Darwin began to question the stability of species. It is generally held that during the weeks spent at the Galpagos Islands, Darwin first considered the possibility of the transmutation of species. The question, at what period during the *Beagle* voyage did his views crystallise?, appears to have been answered by the occurrence of a significant passage "for such facts would undermine the stability of species." in Darwin's unpublished manuscripts dealing with the fauna of Galpagos Islands.

* * *

In spite of warnings given repeatedly, three or four fatalities and many severe burning accidents have resulted from the use of *sodium chlorate* as a weed-killer in New Zealand. Injuries have also resulted to some farmers who have used sodium chlorate mixed with sulphur or sugar for blasting purposes. Two or three farmers have been prosecuted.—(*Chemical Age, Sept.* 1935.)

* * *

An earthquake shock of moderate intensity resulting in minor damages to buildings was felt at Taikkyi, in Burma, on the 1st October at 12.44 p.m. The epicentre is believed to be about 50 miles away from Rangoon and the duration of the shock was 2 minutes.

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Royal Institute of Science, Bombay.—Dr. T. S. Wheeler, Principal of the Institute, has been re-elected Dean of the Faculty of Sciences of the Bombay University for the next academic year.

Prof. P. R. Awati of this Institute and Dr. Venkatraman of the University Technology Institute have been appointed local Secretaries of the Second Meeting of the Indian Academy of Sciences, to be held next December in Bombay.

* * *

The Journal of the Indian Mathematical Society (New Series, Vol. 1, *No.* 6).—The conception of the line of striction of a singly infinite family of curves on a surface is due to C. E. Weatherburn (*vide Math. Gazette, Vol.* 13). Mr. V. Rangachariar (Patna) in a paper in the present issue of the *Journal* examines under what circumstances the line of striction of a system of asymptotic lines of a minimal surface can be a trajectory of the system.

Dr. R. Vaidyanathaswamy, M.A., D.SC., presents a paper on the Extension of the Determinant Concept, wherein by using methods based on Group-Theory, he improves upon a previous publication of his, entitled "On Mixed Determinants."—(*Proc. Roy. Soc. Edinburgh*, 1925.)

R. Vaidyanathaswamy and B. Ramamurti have a note on the "Rational Norm Curve", wherein they make a further study of a correspondence between quadric envelopes in S_n and linear line complexes in S_{n+1} studied by R. Vaidyanathaswamy elsewhere.—(*Jour. Lond. Math. Soc.*, 1932.)

C. N. S.

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Journal of the Bombay Natural History Society.—We have received Vol. **38**, No. 1, of the *Journal of the Bombay Natural History Society, Bombay*, and we note that it abounds in articles relating to faunistic and floristic natural history. There is a most thrilling article on Rhinoceros Shooting in Burma and it makes very interesting reading particularly after following Mr. Morris's account of the hunt for a rare species of Rhinoceros needed for the American Museum of Natural History. Mr. W. S. Thom, the author of the article in the journal, tells us that specimens of *R. sumatrensis* are very common

while the single-horned *R. sondaicus* is not at all met with though it is said to exist in Burma. There are other articles on Game birds, Game sanctuary, Ornithology of Travancore and Cochin, Caddis-flies, Flora of Bombay Presidency, Papaw tree, Beautiful Indian trees, Medicinal and poisonous sedges of India and others. Besides reviewing some important books, a large number of pages is devoted to miscellaneous notes and no less than 43 short articles of natural history interest are published under this head.

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Recent Publications.—

His Majesty's Stationery Office, London.—Department of Scientific and Industrial Research.—Fuel Research Technical Papers, Nos. 40 and 41. The Hydrogenation-Cracking of Tars. Part I. Preliminary Experiments. Price 2*s.* net. Part II. The Preparation of a Catalyst. Price 6*d.* net.

Report of the Food Investigation Board for the year 1934. Price 4*s.*

Cambridge University Press, London.—The Optical Basis of the Theory of Valency, by R. De L. Kronig. 16*s.* net.

Thomas Murby & Co., London.—Transactions of the 3rd International Congress of Soil Science, 1935, Vol. I (23*s.* to members of the International Society and 28*s.* to non-members). Vol. II. (11*s.* to members and 13*s.* to non-members).

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Announcement.—

Indian Central Cotton Committee.—Facilities for Training at the Technological Laboratory, Matunga, Bombay.—As in the past the Technological Laboratory will admit this year two students for training in the elements of spinning and the routine methods of testing cotton fibre and yarn. The selected candidates will be expected to join on the 2nd December 1935 and will conform to the Laboratory regulations regarding hours of work, etc. The course will normally last for a period of six months and a fee of Rs. 50 only will be charged for the full course.

Candidates desirous of admission should submit written applications to the Director, Technological Laboratory, Matunga, Bombay, so as to reach him not later than the 1st November 1935.

* * *

International Geological Congress.—Seventeenth Session, USSR, 1937.

In view of the fact that the twentieth anniversary of the existence of the Soviet Power will be celebrated in 1937, the Government of USSR has decided to summon the Seventeenth International Geological Congress that year.

The session will open in the beginning of August and July will be devoted to excursions before the Congress, and the second half of August and September for excursions after the Congress. The Organisation Committee has proposed the following topics for discussion at the session:—

(1) Problem of Petroleum and Petroleum Resources of the World.
(2) Geology of Coal Fields.
(3) Pre-Cambrian and Mineral Deposits in Regions of its Expansion.
(4) Permian System and its Stratigraphical Position.
(5) Correlation of Tectonic Processes, Magmatic Formations and Ore Deposits.
(6) Tectonic and Geochemical Problems of Asia.
(7) Deposits of Rare Elements.
(8) Geophysical Methods in Geology.
(9) History of Geological Knowledge.

The Committee welcomes suggestions regarding further topics suitable for discussion.

Five excursions taking 15–28 days have been planned before the session ; and four large excursions covering very wide regions and taking 40–50 days, after the session.

Those who wish to offer suggestions to the Organisation Committee concerning the Seventeenth International Geological Congress, are invited to communicate with the Committee, Moscow 4, Kotelnicheskaya Naberezhnaya, 17. Telegraphic Address : Moscow, Geocongress.

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We acknowledge with thanks the receipt of the following :—

"Transactions of the Faraday Society," Vol. XXXI, Parts 9 and 9*a*, September 1935.

"Agricultural Gazette of New South Wales," Vol. XLVI, Parts 7, 8 and 9.

"The Allahabad Farmer," Vol. IX, Nos. 2–5.

"Journal of Agricultural Research," Vol. 51, No. 1.

"Journal of Agriculture and Livestock in India," Vol. V, Parts 3 and 4.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4318–4322.

"The Journal of the Indian Botanical Society," Vol. 14, Nos. 3 and 4.

"Canadian Journal of Research," Vol. 13, No. 2, Sections A, B, C, and D.

"Chemical Age," Vol. 33, Nos. 843–847.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 9.

"The Journal of Indian Chemical Society," Vol. 12, Nos. 8 and 9.

"Experimental Station Record," Vol. 71, Index; Vol. 73, Nos. 1 and 2.

"Indian Forester," Vol. LXI, No. 10, October 1935.

"Forschungen und Fortschritte," Vol. II, Nos. 25–27.

"Indian Forest Records," Vol. I, Nos. 1–4. (Entomological Series.)

"Department of Commercial Intelligence and Statistics, India: Monthly Statistics of the Production of Certain Selected Industries of India," April and May 1935.

"Publications from the Department of Agriculture, Dominion of Canada—

Soil Drifting Control in the Prairie Provinces, by E. S. Hopkins, S. Barnes, A. E. Palmer and W. S. Chepil, Bulletin No. 179—New Series.

Hardy Roses, Their Culture in Canada, by Isabella Preston with contributed Sections on Insect Pests and Diseases, Bulletin No. 17—New Series.

Goat Husbandry in Canada, by A. A. MacMillan, Bulletin No. 177.

Progress Report of the Chief Supervisor, J. C. Moynan, B.S.A., on—

Division of Economic Fibre Production, Progress Report of the Chief Officer, R. J. Hutchinson, for the years 1931 to 1933.

The Illustration Stations in Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Ontario, for the years 1931, 1932 and 1933.

Do. in Manitoba, Saskatchewan, Alberta and British Columbia, for the years 1931 and 1933 inclusive.

Varietal Studies of Flue-Cured, Burley and Dark Tobaccos, by N. A. Macrae and R. J. Haslam, Bulletin No. 178—New Series.

The Vegetable Garden, by W. S. Blair, Pamphlet No. 166—New Series."

"Department of Commerce and Industries, Fisheries and Marine Biological Survey," Fishery Bulletin No. 1 (Union of S. Africa).

"Medico-Surgical Suggestions", Vol. 4, No. 8.

"Memoirs of the Indian Meteorological Department," Scientific Notes, Vol. VI, No. 64.

Some Observations on the Thermal Structure of Cumuliform Cloud, by Flt.-Lieut. R. G. Veryard, B.SC., R.A.F.

"Journal of the Indian Mathematical Society," Vol. I, No. 6.

"Scripta Mathematica," Vol. III, No. 3, July 1935.

"Nagpur Agricultural College Magazine." Vol. 10, No. 1.

"Nature," Vol. 136, Nos. 3434–3438.

"The Journal of the Bombay Natural History Society," Vol. 38, No 2.

"The Journal of Nutrition," Vol. 10, No. 2.

"The Journal of Chemical Physics," Vol. 3, No. 9.

"Science and Culture," Vol. I, No. 5.

"The Indian Trade Journal," Vol. CXVIII, Nos. 1525–1528.

"Indian Journal of Venereal Diseases," Vol. I, Nos. I–III.

CATALOGUES.

"Mitteilungen über Neuerscheinungen und Fortsetzungen," 1935, Nummer 4 (September) (Verlog von Gustav Fischer in Jena).

New Books, Autumn 1935 (Messrs. Edward Arnold & Co., London).

Academies and Societies.

National Institute of Sciences of India:

August 24th, 1935. The following papers were read and discussed:—

(1) R. N. CHOPRA, S. N. MUKHERJEE AND K. V. KRISHNAN: *A Note on the Role of Electrical Charge in the Phagocytosis of Red Cells in Malaria.*—It is now an accepted fact that the immunity as observed in malaria is the outcome of the phagocytic activity of leucocytes. The idea regarding this activation on the part of the phagocytes still centres round the formation of a specific antibody in the system as in bacterial infections, although the existence of such an antibody could not be definitely established by different workers; (Thomson, J. G., *Brit. Med. Jour.*, 1918, **2**, 628; Kingsbury, A. N., *Trans. Roy. Soc. Trop. Med. Hyg.*, 1927, **20**, 359; Manson Bahr, P., *Trans. Roy. Soc. Trop. Med. Hyg.*, 1927, **21**, 63, etc.). Brown (*Brit. Jour. Exper. Path.*, 1933, **14**, 413) from an analogy of the changes in the proteins of the serum and in the electrical charge of red cells indirectly indicated the probability of the existence of an antibody which, by reducing the electrical charge on red cells, was instrumental in bringing about ingestion by leucocytes, though he admitted that the action of serum in such cases was not specific. The work of Chopra and Chaudhury (*Ind. Jour. Med. Res.*, 1933, **21**, 273) showed however that the electrical charge of red cells in human malaria did not always show a reduction, but on the contrary a marked increase in many cases. Hence the immunochemical explanation of the increased phagocytosis in malaria did not seem to be adequate specially in view of some definite biochemical alterations observed in the blood.

The present work was done on *Silenus rhesus* monkeys with a heavy infection (nearly 70% of the red cells) of *Plasmodium knowlesi.* Migration velocity in an electric field of infected and uninfected red cells were determined in the different stages of parasites' growth. The migration velocity of the reticulocytes, popularly believed to be free from protozoal attack, was also determined. The first point observed was an inequality of speed between infected and uninfected cells that was manifested by the overtaking of one cell by another. Infected cells, in general, were found to be slower. This was contrary to all experience in the case of normal cells. Secondly, a study of the variation of migration velocity in different stages of parasites' growth revealed an increase of migration velocity in the ring stage and a marked decrease in the fully mature schizont stage as compared to normal cells. The healthy cells in these infected specimens all along showed a slight increase. An inference was arrived at from these observations that towards the end of schizogony when the mobility was comparatively lower, the phagocytosis of such infected cells should be more prominent. The equality of the migration velocities of reticulocytes and adult red cells pointed to the possibility that reticulocytes should be equally liable to be infected with parasites as adult red cells are found to be. Infected reticulocytes were actually detected in one case and the relative freedom of these from infection was explained as not due to any peculiarity on the part of such cells but probably to their insignificant numbers in the blood, owing to which, according to the calculus of probability, a small infection should be the result.

The relationship between the migration velocity and the electrical charge was discussed in the light of Lamb-Helmholtz equation: $U_0 = D.E/4\pi$. The relationship between electrical charge and phagocytosis was again given by the term $e^{-q \cdot q'/D.d.k.T}$. U_0 represents migration velocity per unit time, per unit potential gradient; D, the dielectric constant of the medium; E, the potential of the Helmholtzian double layer: q, the charge on a red cell; q', the charge on an ingesting white cell; d, the distance between the centres of these two types of cells at the point of their nearest approach; k, the Boltzmann constant; T, the temperature in the absolute scale and e, the base of natural logarithms. This term was deduced from a consideration of the

electrical work necessary for the approach and collision between two similarly charged particles as in the case of colloid micelles. From this the inadequacy of the part played by the electrical charge of red cells alone in such phenomenon was clearly evident; the importance of the charge of white cells as well as of the dielectric constant of the medium was simultaneously brought out from a theoretical point of view. The changes in the cholesterol content of the plasma and its effect upon the phagocytosis of red blood-cells in a few cases justified our conclusions to a certain extent. The phagocytosis of the actual protozoa during their short extracellular existence was dealt with from the mathematical considerations of probability and finally the importance of the physical factors and of the biochemical alterations in the plasma were also brought out from a theoretical point of view.

(2) W. D. West: Nappe *Structure in the Archæan Rocks of the Central Provinces.*—Evidence is brought forward to show that around Deolapar, in the Ramte tahsil of the Nagpur district, there occurs a sharp discordance in the succession of the Sausar series, at which position one or more stages are missing. The trace of the discordance is an irregular closed line, and it is clearly not a simple thrust. The details of the structure suggest that there is a recumbent fold resting upon the surrounding rocks, from which it is separated by the discordance. Both the recumbent fold and the "slide" upon which it rests have been further folded into a syncline. A study of the lithology also supports this view of the structure, since the rocks forming the *nappe* are of a different facies from the rocks surrounding it. It is suggested that the two sets of rocks were far separated at the time of their deposition, and have since been brought into juxtaposition with one another by horizontal movement along the slide.

(3) Horace Barratt Dunnicliff and Jnanendra Nath Ray: *Loss of Morphine in Indian Opium on Storage.*—(*a*) Moist opium does not lose morphine on storage. (*b*) Opium dried at 60° C. stored in contact with air suffers a rapid loss of morphine. This is not completely prevented by storage in corked and paraffined bottles. (*c*) Opium dried at 98–100° and stored out of contact with air does not lose morphine to any appreciable extent. (*d*) There is no evidence of the formation of ammonium salts as a result of the oxidation. (*e*) An enzyme (peroxidase) has been isolated from Malwa opium which may be the factor responsible for the decomposition of morphine. (*f*) A fungoid growth noticeable on moist opium has been identified as that of *Scopulariopsis brevicavtis*, var. *glabra Thom.* (*g*) When this fungus is made to grow in a dilute solution of morphine hydrochloride in a suitable nutrient medium, a slight fall in the concentration of morphine is observed but the specific rotation of the solution does not change appreciably.

Indian Academy of Sciences:

September 1935. SECTION A.—R. Padmanabhan: *Fluorescence in Cyclohexane.*—With the help of a continuous distillation apparatus it is shown that pure cyclohexane has no fluorescence. K. L. Ramaswamy and G. Gundu Rao: *The Density and Compressibility of Silicane and Silicoethane.*—A convenient apparatus for their simultaneous measurement and the results obtained are given. R. S. Krishnan: *Molecular Clustering in Binary Liquid Mixtures (Variation with Composition and Temperature).*—A study of the intensity and depolarisation of the light scattered transversely by mixtures of phenol and water at different temperatures shows that formation of clusters and their size depend upon temperature and composition. M. A. Govinda Rau and S. Satyanarayana Rao: *On the Dipole Moment of Tetralin.*—The moment is only small of the order 0.4×10^{-18}, and not 1.66×10^{-18} as reported in the literature. B. V. Raghavendra Rao: *Doppler Effect in Light Scattering in Liquids. Part II.—Polarisation of the Transversely Scattered Radiations.*—With the typical liquids carbon tetrachloride, toluene and carbon disulphide, it is significant that besides the two Doppler components, the central component is also practically completely polarised. I. Chowla: *A Theorem on the Addition of Residue Classes: Application to the Number $\Gamma(k)$ in Waring's Problem.* V. N. Thatte: *Magnetic Double Refraction and Light Scattering in Fused Nitrates.*—The magnetic and optical anisotropies of the NO_3 group are the same as in nitric acid and crystalline nitrates. S. Ramachandra Rao: *Diamagnetism of Copper.*—On colloidalisation of copper, the diamagnetic susceptibility increases, the critical diameter below which large changes occur being $0.8\,\mu$. C. S. Venkateswaran: *The Raman Spectrum of Phosphorus.*—Yellow phosphorus as vapour, liquid, solid and solution in carbon disulphide has been studied. M. V. Nabar and T. S. Wheeler: *The Kinetics of Heterogeneous Organic Reactions: The Reaction between Benzyl Chloride and Solid Silver Nitrate.*—The reaction is independent of the amount of benzyl chloride but is proportional to the surface of silver nitrate present. C. S. Venkateswaran: *The Raman Spectra of Dioxane and Tetralin.* R. Ananthakrishnan: *The Raman Spectra of Heavy Water.*—The principal band is found to have a triple structure and two other new bands have also been observed. S. Bhagavantam: *Raman Spectrum of Deuterium: I.*—With deuterium at 17 atmospheres, five rotational lines and one vibrational line are recorded. The positions and intensities of these lines provide the first experimental confirmation of the theories regarding the D_2 molecule. S. Bhagavantam: *Raman Spectrum of Hydrogen Deuteride.* L. Sibaiya: *Hyperfine Structure in Selenium, Palladium and Gold.*—In Selenium and Palladium none of the levels examined reveals any even isotope displacement.

SECTION B.—T. N. S. Raghavachari and P. V. Seetharama Iyer: *The Use of Activated Carbon in the Purification of Water in the Tropics (The Madras City Water Supply).*—Activated granular carbon when used in a slow sand filter, as a sandwiched layer 1½″ thick, is effective in removing the colour, taste and odour. The organic matter is reduced; the carbon maintains its efficiency even after 2 years' continuous service. Charles S. Pichamuthu: *The Conglomerates and Grits of Kaldurga, Kadur District, Mysore.*—As the result of a detailed study of the pebbles and the matric, the writer has come to the conclusion that the conglomerates are not autoclastic as held hitherto, but that they are of a sedimentary origin.

M. J. PRESSWALLA AND C. J. GEORGE: *The Respiratory System and the Mode of Respiration of the Water-Bug*, Sphærodema rusticum *Fabr.*, *with Remarks on those of* Nepa, Laccotrephes *and* Ranatra.—The respiratory systems of the two forms of adult *Sphærodema rusticum* exhibiting peculiar alary dimorphism have been studied in detail. (MISS) KAMALA BHAGVAT AND MOTNAHALLI SREENIVASAYA: *A Dilatometric Method for Studying the "In Vitro" Digestibility of Milks.*—The dilatometric method affords an accurate and simple method for studying the digestions of milks. The behaviour of the casein particles in cow's milk towards tryptic digestion does not appear to be different from that of the casein particle in artificial solution. N. C. DATTA: *Investigations on Metallic Contamination of Foods. Part II.—Effect of Cooking and Storage of Food-stuffs in Aluminium Vessels.*—Feeding experiments with rats have shown that food prepared in aluminium vessels has no harmful effect on growth, reproduction and general well-being of the animals. H. B. SREERANGACHAR: *Dilatometric Studies in the Enzymic Hydrolysis of Polysaccharides. III.—Hydrolysis of Starch, Amylose and Amylopectin by Takadiastase.*—The depression per millimol release of maltose from potato starch, soluble starch (Lintner), amylose and amylopectin, are respectively 4.0, 4.0, 3.6 and 3·6 mm.^{3}. The depression per degree fall in rotation is 10.7 mm.^{3} in the case of both amylose and amylopectin.

Symposium:

October 5th and 6th, 1935. *Disease Resistance in Plants* (held at Coimbatore).

GENERAL.

(1) L. D. GALLOWAY (Pusa): *The Control of Fungal Parasites by the Plant.*—The control of harmful fungi can be considered under (*a*) infection, (*b*) humidity, (*c*) nutrition, (*d*) temperature, and (*e*) atmosphere. Infection may be seed, soil or air-borne and disease may be avoided by minimising chances of infection. In the study of the onset and progress of diseases humidity is an important factor but very little work appears to have been done. The problem of specificity of certain pathogenic fungi and the cosmopolitan nature of others has not been satisfactorily solved. The role of soil nutrient and the action of poisons and toxins on plants has to be clearly investigated. The growth of the parasites and the resistance of the host are controlled by temperature and the aid of certain chemicals like CO_2, NH_3, $CH_3 . CHO$, which have an inhibitory effect on the growth of fungi can be invoked for controlling several fungus diseases. The mechanism of disease resistance presents fresh series of problems for each host plant and each parasite and no general formula is to be anticipated.

DISEASES OF THE PULSE CROPS.

F. J. F. SHAW (Pusa): *The Inheritance of Morphological Characters and of Wilt Resistance in Rahar* (Cajanus indicus).—From a study of the F_1, F_2 and F_3 generations of a cross between a resistant and susceptible varieties of *Cajanus indicus*, evolved at Pusa, it has been shown that the resistance to wilt is conditioned by the presence of the complimentary character. Morphological characters like flower colour, erect or spreading habit of growth, tall or short structure of plant, crowded or open inflorescence and brown and grey markings of the seeds are inherited *independently* of the factors influencing the resistance to wilt.

V. RAMANATHA IYER AND R. BALASUBRAHMANYA IYER (Coimbatore): *A Preliminary Note on the Mode of Inheritance of Reaction to Wilt in* Cicer arietinum.—The reaction to wilt in this crop belongs to the blending type of inheritance manifesting transgressive variation. The type of branching and the colour of the seed coat do not bear any relation with the reaction to disease.

DISEASES OF THE COTTON.

K. N. AMBIGAOKAR AND YESHAVANT D. WAD (Indore): *Studies in Disease Resistance. I.—Cotton Wilt and Environmental Conditions.*—An account of three years' work on the physiology of the cotton plant in relation to wilt. Field observations showed that the progress of wilting in the field may be modified by soil differences, irrespective of its inhibition intensity. Root activity in the upper soil zones was found to be significantly less in diseased plants than in healthy ones. An excessive supply of nitrogen, alone or with phosphate, increased susceptibility. Farmyard manure had no influence.

I. MADHUSUDAN RAO AND YESHAVANT D. WAD: *Studies in Disease Resistance, II.—Leaf-Roll and Red-Leaf in American Cottons.*—Physico-chemical studies of the saps of healthy and affected wilt plants have been made. The pH was greater and the osmotic pressure lower in healthy leaves than in the diseased ones. Studies on soil profiles and the root systems of healthy and affected plants have been carried out in detail. There is generally no visible difference in the soil profiles, under healthy and diseased plants. The root-studies indicate that the high death-rate (as compared with that in normal plants) in the active roots in the upper zone (1 foot) reduce the activity in the roots of lower zone in diseased plants. The disease was produced whenever the surface soil was deflocculated after long continued wetting.

SPIKE-DISEASE OF SANDAL.

M. SREENIVASAYA: *Spike Disease and Resistance in Sandal* (Santalum album *Linn.*) *with Special Reference to its Control.*—The control of this disease presents special problems since the disease affects an extensive crop which takes several years to reach a stage of exploitable maturity. The plant demands during this long period a considerable amount of care and attention by way of tending, host conservation and fire protection. The selection of suitable host plants has proved useful in imparting immunity to sandals effecting rogueing by defoliation has proved useful to detect masking plants. While enforcing methods of plant sanitation has proved helpful in controlling this infectious disease, success has not yet attended the attempts to evolve resistant strains.

B. N. SASTRI: *Physiology of the Spike Disease of Sandal.*—The factors responsible for the accumulation of starch, mannitol and succinic acid in spike tissues have been discussed.

PIRICULARIA ORIZÆ.

K. RAMIAH AND K. RAMASWAMI: *Breeding for* Piricularia *Resistance in Rice* (Oryza sativa).—Breeding work has resulted in obtaining two strains which are not only resistant to the disease but also give a bigger yield than the suscepti-

ble variety. The inheritance studies in this cross would make it appear that resistance to *Piricularia* is a simple recessive.

DISEASES OF SUGARCANE.

C. S. KRISHNASWAMY: *Studies in Disease Resistance in Crop Plants in the Madras Presidency. II.—Estimation of Disease Resistance in Sugarcane Mosaic.*—150 varieties of cane have been tested since 1926 for their resistance to mosaic. The percentage of incidence of mosaic in a variety when interspersed with the diseased cane Co 213, which is taken as standard, gives a measure of the relative resistance of the variety under trial. The studies have shown that immune varieties are rare as even highly resistant varieties are capable of taking up infection under special conditions. An analysis of the factor of disease resistance on morphological and histological characters has been made.

N. L. DUTT, SYED ABBAS HUSSAIN AND M. K. KRISHNASWAMI: *A Note on the Breeding of Sugarcane Varieties Resistant to Mosaic.* As a result of the extensive inter-varietal, inter-specific and inter-genetic crosses, a large number of seedlings are available representing all gradations of resistance, to mosaic, from susceptible to immune. Seedlings which contain the blood of *Saccharum spontaneum* have proved highly resistant or immune, while on the other hand those that do not contain *spontaneum* blood show a high percentage of mosaic infection. With regard to the mosaic resistant varieties, cases have been recorded where the resistance is found to vary geographically. This is perhaps due to the existence of physiologic races of the causal agent.

K. L. KHANNA: *Some Aspects of Disease Resistance in Sugarcane. I.* Plant Vitality, Tentative 'Susceptibility' and 'Resistance' ranges to incidence of pests (shoot borers) and diseases (top rot and red stripe), at different stages of growth, in different seasons and from different treatments such as manures, irrigation and soil types, have been measured and by injecting oxidising agents and certain chemicals and also exposure to component rays of white light, it is possible to raise the vitality of the plants to resist diseases and pests. *II. Morphological and Physiological.*—Some of the characters responsible for differences in varietal predisposition and resistance have been noted. *III. General.*—The relative position of 'major' and 'minor' diseases has been discussed in relation to the rapidly changing varieties as a result of breeding improved types of sugarcane.

SHOOT ROT OF COCONUT.

J. S. PATEL AND A. P. BALAKRISHNA NAYAR: *Natural and Induced Resistance to Shoot Rot* (Gleosporium sp.) *in the Coconut.*—From observations made on large varieties of coconut collected from different parts of the world, and grown at the Government Agricultural Research Station, Pilicode, it is seen that a variety from Philippines showed the lowest percentage of infection (37 per cent.) and a variety from Mysore showed the highest (87 per cent.). The disease occurred in palms 3-9 years of age and thereafter the trees are generally less susceptible. The susceptibility is more pronounced in trees planted on the surface than in the trees planted at a depth of 3 feet. The incidence of disease is considerably reduced when potassium sulphate is applied to the soil.

The Academy of Sciences, U. P.

September 1935. *Special Meeting of the Academy.*—It was resolved (1) to change the name of the Academy to "The National Academy of Sciences, India" and (2) to raise the number of Fellows from 30 to 100.

September 18th, 1935. *Ordinary Meeting of the Academy of Sciences, U.P.*—The following papers were read and discussed:

RADHA RAMAN AGARWAL AND SHIKHIBHUSAN DUTT: *The Chemical Examination of Punarnava or* Bœrhaavia diffusa *Linn. Part II.—The Isolation of an Alkaloid Punarnavine.* B. P. PANDE: *On Amphistomes with Central Pouch from India.* HRISHIKESHA TRIVEDI: *The Absorption Spectrum of Hydrogenchloride Molecule and its Upper Unstable State.*—By the help of a theory developed by the author previously it is possible to calculate the form of the potential energy of the unstable state of hydrogen chloride from the measurements of its absorption coefficient. The form has been known only qualitatively up till now. HAR DAYAL SRIVASTAVA: *New Hemiurids (Trematoda) from Indian Marine Fishes. Part I.—New Parasites of the Sub-Family* Prosorchinæ *Yamaguti,* 1934. HAR DAYAL SRIVASTAVA: *New Allocreadids (Trematoda) from Indian Marine Fishes. Part I.—New Parasites of the Genus* Halicometrina *Linton,* 1910. HAR DAYAL SRIVASTAVA: *New Allocreadids (Trematoda) from Indian Marine Fishes. Part II.—New Parasites of the Genus* Decemtestis *Yamaguti,* 1934.

The Indian Physical Society:

September 21st, 1935. An ordinary monthly meeting of the Indian Physical Society was held at 3 P.M. in the Applied Physics Seminar, University College of Science, Calcutta, with Principal B. M. Sen, M.A., I.E.S., in the Chair. The following papers were read and discussed:

(1) N. K. SAHA (Lahore): *Pressure Coefficient of Electrical Resistance of Metals.* (2) P. LAL AND K. LAL (Lahore): *On the Statistical Theory of Neutral Atoms.* (3) D. V. GOGATE (Baroda) AND D. S. KOTHARI (Delhi): *On the Measurement of the Quantity of Light by the Photoelectric Cell.* (4) K. PRASAD AND B. N. GHOSH (Patna): *Studies on Water Jets.* (5) P. SYAM (Calcutta): *On the Absorbing D-Layer of the Ionosphere.* (6) P. C. MAHANTI (Calcutta): *Fine Structure Analysis of Red Bands of Magnesium Oxide and Isotopic Effect.* (7) P. C. MAHANTI (Calcutta): *Potential Energy Curves and the Structure of the Alkaline Earth Oxides.* (8) S. DATTA AND M. DEB (Calcutta): *Investigations on the Ultraviolet Absorption Spectrum of* Ce^{+++}*ion.* (9) H. P. DE (Calcutta): *State of Polarisation of Continuous X-Rays from a Thin Aluminium Anticathode.* (10) H. P. DE (Calcutta): *On the Emission of Positrons from Bismuth.*

The Indian Chemical Society:

August 1935. H. B. DUNNICLIFF AND BRAHM PRAKASH: *Action of Hydrogen Sulphide on Insoluble Chromates. Part I.—Lead Chromate and Silver Chromate.* S. S. BHATNAGAR, P. L. KAPUR AND N. R. VERMA: *Magneto-Optical Rotation of Uranyl Salts.* R. PADMANABHAN AND S. K. KULKARNI JATKAR: *The Anomalous Rotatory Dispersion of l-β-Pinene—Part I.* B. B. DEY AND T. K. SRINIVASAN: *Studies in the Cotarnine*

Series. Part IV.—5-Bromonarcotine, 5-Bromocotarnine, 5-Bromohydrocotarnine and 5-Bromonarceine and their Derivatives. DUHKHAHARAN CHAKRAVARTI: *Synthesis of Coumarins from Phenols and β-Ketonic Esters. Part III.—Use of Various Condensing Agents.* PHULDEO SAHAY VARMA AND K. S. VENKAT RAMAN: *Nitration. Part V.—Nitration of Monohalogen Derivatives of Xylenes.* PULIN BEHARI SARKAR: *The Chemistry of Jute-Lignin. Part VIII.—Methylation of Lignin.* PULIN BEHARI SARKAR: *The Chemistry of Jute-Lignin. Part IX.—Acetylation of Lignin.* S. M. MEHTA AND (MISS) OLIVE JOSEPH: *The Viscosity of Titanium Dioxide Sol in Presence of Electrolytes.* R. PADMANABHAN: *A Modified Photographic Method for Substances of Small Rotatory Dispersion.*

September 1935. K. VENKATA GIRI: *Studies in Salt Activation. Part II.—Influence of Salts on the Stability of Amylase.* M. M. RAM MOHAN RAO AND S. K. KULKARNI JATKAR: *The Heats of Transition of Triglycerides.* MAHADEO PRASAD GUPTA AND SIKHIBHUSHAN DUTT: *Dyes Derived from Acridic Acid.* SACHINDRA NATH ROY: *A New Volumetric Method for the Estimation of Lead.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *Chemical Examination of* Cuscuta reflexa, *Roxb. Part II.—The Constitution of Cuscutalin.* NRIPENDRA NATH CHATTERJEE: *Studies in Diphenyl Series. Part III.—A New Route to Phenanthrene.* M. A. HAMID GURCHARAN SINGH AND H. B. DUNNICLIFF: *The Action of Hydrogen Sulphide on the Chromates of Hydrogen, Ammonium, Sodium and Potassium.* RANAJIT GHOSH: *Synthesis of Hexahydro-a-Coumaranone.* B. B. DEY AND (MISS) P. LAKSHMI KANTAM: *Studies in the Cotarnine Series. Part V.—Condensation of Cotarnine with Aromatic Nitro-Aldehydes.* HARISH CHANDRA GOSWAMI AND PULIN BEHARI SARKAR: *On the Triple Nitrites of the Rare Earths and a New Micro-Test for Cæsium.* K. N. KAUL AND G. S. AHLUWALIA: *Action of Cotarnine and o-Nitrobenzaldehyde.* U. S. KRISHNA RAO AND B. L. MANJUNATH: *On the Supposed Occurrence of Acids with Uneven Number of Carbon Atoms in Vegetable Oils and Fats. Part II.—The Acid Fraction of Mean M.W. 354 from the Seeds of* Butea frondosa, *Roxb.* JAGRAJ BEHARI LAL: *Metallic Uranium in Organic Synthesis—Part II.* PRIYADA RANJAN RAY AND HARIBOLA SAHA: *A Short Note on the Chromium Biguanide Complexes.* DUHKHAHARAN CHAKRAVARTI AND BAIDYANATH GHOSH: *Synthesis of Coumarins from Phenols and β-Ketonic Esters. Part IV.—Coumarins from 4-Chloro and 2-Nitroresorcins.* HIRENDRA NATH DASGUPTA: *Heterocyclic Compounds containing Arsenic in the Ring—A Preliminary Note.*

The Indian Botanical Society:

September 1935. T. EKAMBARAM AND I. M. RAO: *Studies in Absorption and Respiration—II.* R. E. COOPER AND S. A. PASHA: *The Osmotic Pressure and the H-Ion Concentration of Sea-Weeds in Relation to those of Sea-Water.* S. C. DIXIT: *The Charophytes of the Bombay Presidency.* J. F. R. D'ALMEIDA: *On the Occurrence of* Gymnogramme calomelanos *Kaulf. in India.*

October 1935. R. H. DASTUR AND M. R. RAUT: *Carbohydrate Nitrogen Ratio of the Shoots of Some Tropical Trees.* P. ABRAHAM: *Occurrence of Extracapellary Ovules on the Floral Axis in Cotton.* A. B. SARAN: *The Effect of Wounding on Respiration in the Starving Leaves of* Aralia guilfuylei. D. B. MUKHERJEE: *Notes on a Collection of Plants from Mahendragiri.* T. C. N. SINGH: *Notes on the Teratology of Certain Indian Plants—VIII.* P. MISRA: *On the Peg of the Seedlings of* Cucurbita maxima *Duchesne.* B. N. SARKAR: *Note on the Movements of* Basella cordifolia *Lamk.* M. B. RAIZADA: *Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain.* A. C. JOSHI: *Number of Chromosomes in* Suæda fruticosa *Forsk.*

Industrial Outlook.

Fermentation of Molasses: Use of Pure Yeast Acclimatised to Antiseptic.

THE fermentation process with pure yeast is different from that with ordinary yeast because one knows when it commences and when it ends. It is a logical operation—almost mathematical.

For each vat of fermentation the leaven is changed so that the operation is always commenced with vigorous pure yeast. It is easy to understand that in this condition, the bacteria which are in the molasses are entirely subordinate to the yeast. This factor is more marked because pure yeast can tolerate large doses of antiseptics in the special apparatus, whereas the bacteria are completely paralysed by the antiseptics in the apparatus and in the large vats of fermentation. Similarly, if any mistakes occur during the operation of the yeast-apparatus or during its sterilisation, these are negligible owing to the action of the antiseptics.

Yeast which is continually changed enters the fermentation room with the maximum of strength and of diastatic power. The inversion of saccharose is effected in a short period and the transformation of the glucose into alcohol is complete.

The apparatus is so arranged that it is possible to clean it thoroughly twice a day without interruption of the process. This is not possible with the ordinary method of pure yeast culture.

A recent process developed by a French firm adapts laboratory methods of pure yeast culture for industrial purposes, and prevents the "negative phenomena" which up to now have paralysed its development.

DESCRIPTION OF PURE YEAST APPARATUS.

The pure yeast apparatus has an auxiliary equipment which supplies it with a current of purified air.

Supply of pure air which is an essential factor is secured with a pump which sucks air from above the roof of the distillery, and sends it into a filter of steel sheets filled with salycilic-cottonwool. Below the filter is placed a washer, two-thirds of which is filled with clean stones to distribute the air in the antiseptic liquid, kept in the apparatus.

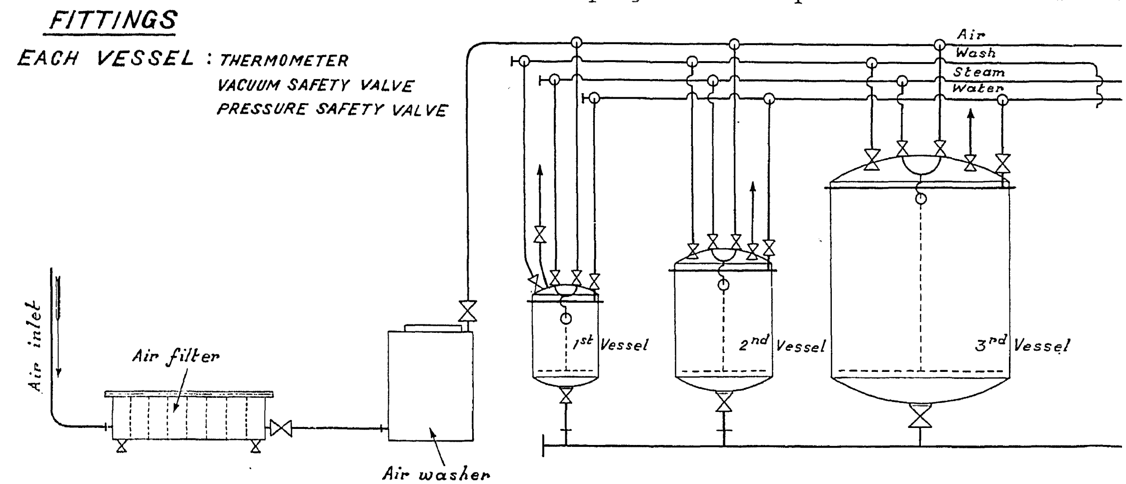
Basins for Culture.—Three basins are available for the culture. They are made of red-copper, tinned inside and have a capacity of 22, 55 and 330 gallons. As each of the three basins must be sterilised, aerated, cooled and connected with each other, they are fitted with 4 sets of pipes. Each basin is fitted with a pipe to convey the sterilised air, and a coil to carry either steam for sterilisation or water for cooling.

On the top of each basin is a manhole, a pipe with a valve for the escape of the gases, and two safety valves. A thermometer fitted to each apparatus enables the variations in temperature to be watched.

The basins are connected with each other at the bottom by a pipe which can serve (1) as an outlet for the yeast, (2) as an inlet for the wash, (3) for cleaning the apparatus, and (4) as an inlet for water and steam. The piping can be sterilised completely in an easy manner.

Each basin is fitted with two cocks for withdrawing samples, with a view to watching the fermentation.

It is easy to visualise with the help of the accompanying diagram how this equipment (manufactured by Ateliers Pingris and Mollet Fontaine Reunis, Lille, France) is operated to furnish a steady supply of pure yeast by progressive multiplication in the three basins.



DIAGRAMMATIC ONLY

The high content of the antiseptic and the strength of the yeast permits of the stoppage of the development of bacteria until the vat is filled. During this period, the yeast apparatus continues to furnish fresh yeast and every 14 hours a pitch tank will be ready for a new fermentation.

If the yeast apparatus is correctly operated, it can run continuously without changing the yeast for a period of 3 to 4 months, and the efficiency from actual experience in India, reaches more than 90 per cent. of the theoretical.

Ninth Conference of the Indian Mathematical Society.

THE Editor, *Mathematics Student*, writes:

We beg to remind our readers of the Ninth Conference of the Indian Mathematical Society which meets at Delhi at the invitation of the Delhi University between the 19th and 21st of December (both inclusive) this year. It is hoped that a large and representative body of members will participate and ensure its success. Those who intend attending the Conference are requested to communicate with Dr. Ram Behari, M.A., Ph.D., Professor, St. Stephen's College, Delhi, who is the Chairman of the Local Committee. As the programme will soon be printed, it is requested that abstracts of papers intended for the Conference be sent to Dr. A. Narasinga Rao, Professor of Mathematics, Annamalai University, Annamalainagar, without delay.

Reviews.

THE USE AND MISUSE OF LAND. By R. Maclagan Gorrie. (Oxford Forestry Memoirs, No. 19, 1935.) Pp. 80. (The Clarendon Press, Oxford.)

It was long the fashion for the Agriculturist to think of the Forester as his natural enemy. This view, born of ignorance, is gradually disappearing but not yet dead. There is as yet, however, no widespread appreciation and occasionally not even recognition that sound Forestry instead of being incompatible with flourishing Agriculture, is an important and even integral part of it. The Forester and the Agriculturist are both vitally interested in the quality and quantity of their common basic commodity—the Soil. But, strangely enough, books which take a long-term view of Forestry and correlate its fundamental bearing to soil are all too few. It is for this reason that Dr. Gorrie's interesting Memoir is to be welcomed.

The book deals primarily with grazing and its relation to Soil Erosion. Indeed, the author who at first set out to trace "The Correlation of Erosion Damage and Grazing in Forest Lands" subsequently enlarged the scope of his enquiry because he felt that "if land as a whole could be put to its best uses......the menace of overgrazing would automatically disappear". The value of Dr. Gorrie's book lies as much in this significant standpoint of the author as in the suggested solutions of the problem. Much the greater part of the data in the book relating to Land Erosion are from the United States and some at least of the lines of attack interest us in India as showing how the problems are tackled elsewhere rather than as how they should be here. Such concepts as "Palatability" of fodder to livestock, "Forage Factor" (defined as, Average Type Palatability × Average Type Density) dealt at some length in the Memoir are of little more than academic interest to the Indian student.

The volume opens with a fascinating account of "Forestry as a Factor in Land Management". A survey of some aspects of grazing leads the author to a consideration of Grazing as a primary cause of Soil Erosion. The control of stream flow is then discussed and there is a separate chapter on "Farm Erosion and its Control". The title of the last chapter "Public and Private Control of Land" almost suggests a discussion of socio-economic theories of land ownership of which, however, the author steers clear and gives short accounts of Erosion Control and Regional Land Planning as practised in the United States.

The use of the expressions "concave upwards" and "convex upwards" in describing Soil Profiles (p. 38) is a little jarring. The units employed in the tables are not always happy. Thus land erosion in Table I (p. 50) is expressed in "cu. yds. per sq. mile" while in Table II (p. 51) the soil loss is quoted in "tons per acre". A couple of Americanisms, "on to which" (p.74) and "Alinement" (p. 76) are noticeable.

A bibliographic list is given at the end of each chapter. But for a semi-jocular reference to Wang's "Grundriss der Wildbachverbauung" in the text (p. 49) and a reference to Cabianca's paper (p. 60), the selection ignores the work of the Continental schools of thought. A few appropriate references to the pioneer work of the great German and specially Russian pedologists would very considerably add to the value of the Bibliography.

The Memoir should be read by every one interested in the intelligent utilisation of land.

EMMENNAR.

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THREE PHILOSOPHERS. By W. R. Aykroyd. (William Heinemann, Ltd., London, 1935.) Pp. 227. Price 10*s*. 6*d*.

In the history of every nation there are periodically recurring moments when the nation wakens to a national consciousness. To the French people such a historic moment came, when the public discovered the injustice of the verdict of the sanguinary Tribunal of the Revolution, to guillotine Lavoisier. The story of the life and work of this pioneer of modern chemistry makes fascinating reading to which a pathetic turn is given by the exceptionally tragic circumstances that attended his end.

In the present volume, the author gives primarily a biography of Lavoisier to which are added the lives of the two eminent English scientists, Priestley and Cavendish. These latter two were Lavoisier's contemporaries and rivals in the field of science. As an excuse for the inclusion of these two biographical sketches when his main purpose seems to be to lay bare the rather unfamiliar

life-history of the French scientist, the author suggests that the achievements of no scientific worker can be studied with advantage without reference to those of his contemporaries whose work no doubt must dovetail with his own. This method is amply justified in as much as certain obscure points in regard to claims for priority of discovery raised by some biographers have been set at rest. The lives of the three great figures of modern science are pursued on parallel lines and wherever appropriate, their attainments as men and scientific workers are critically compared.

Lavoisier came from the solid middle class and had a good start in life. The family traditions would have shaped out an entirely different course for young Lavoisier, but his native genius triumphed and made him elect a scientific career. To him the attainment of scientific distinction was of paramount importance. His chief claim to our remembrance and admiration rests on the laurels he won in the field of science, though he rendered signal service to the state and society as an administrator of the Revenue Farm and as the able head of several commissions on social reform. To Priestley all the advantages which birth and wealth could give were denied by nature, and his early education took place in an atmosphere of dissenterism. So it is small wonder that his mental horizon was dominated by theology in the light of which all other considerations were unworthy of serious attention. The scientific career of Priestley was spasmodic and all his major discoveries were made in fits and starts. Scientific research to him was a source of profound amusement that could fitly occupy his leisure. Like Saul, who came upon a kingdom when he was seeking his father's asses, he stumbled upon great discoveries. The history of the social life and scientific career of Henry Cavendish is a study in contrasts. Although coming of an aristocratic stock he inherited none of the gifts that go to make men successful in society. Aversion to society and in particular to women, was but one among a host of curious sadistic tendencies. Strange tales are current of how he avoided all contact with women. Coupled with this remarkable psychosis was an intellect, which, to say the least, was of the first rank. Science was the one light that relieved the genuine gloom of this singular mind.

Apart from the biographical interest in the book the serious student of chemistry finds much food for thought. The refutation of the infamous theory of "phlogiston" which was obstructing the progress of chemistry for more than a century, by Lavoisier and unwittingly by Priestley himself has been developed at length in its historical and logical sequence. Another topic of general interest is the establishment of the composition of water by Cavendish, which is all the more striking as nothing like scientific technique existed then. Lavoisier was the first to study metabolism and related phenomena which have culminated in the vast and fruitful science of Nutrition.

The background of these biographies is undoubtedly the troubled times of the latter half of the eighteenth century. The lives of at least two of the personages are coloured by the French Revolution, and unfortunately one of them was victimised by its bloody tyranny. The passages where the Reign of Terror is depicted, speak eloquently of the author's abilities as a descriptive writer. The mock trial of the Revenue Farmers before the Revolutionary Judges is at once vivid and pathetic in the extreme.

Like many a great man Lavoisier owed in great measure his success to the unremitting devotion of his wife. Any sketch of his life would be incomplete without a reference to Marie-Annés who was his collaborator and inspirer. The author has done her ample justice by clearly indicating the nature of the co-operation which subsisted between them, which in great measure contributed to their joint successes. In the closing chapters of the book her history after the death of Lavoisier is narrated which serves to vindicate her character though she accepted the suit of the Count Rumford.

Speaking of the style of the author we admit without hesitation, that, though he is a specialist in a highly technical branch of science, his power of exposition may well be coveted by any literary man. The narrative is very lucid and is enlivened by anecdotes relating to incidents in the lives of these three scientists. English writers have meted out scant justice to Lavoisier who has been accused of appropriating others' discoveries to his credit. But in Dr. Aykroyd the French Chemist finds an enthusiastic champion.

Of the essential accomplishments for good citizenship, one of the most necessary factors

is perhaps the development of the historical sense. Among those that foster the cultivation of this sense most are the biographies of great men who have contributed to the public weal. To all those who wish to make a beginning in this direction Dr. Aykroyd's *Three Philosophers* is eminently suitable. The book provides the necessary background and the materials to build upon. The multiplication of such books will obviate the keenly felt desideratum as the literature of this kind is none too profuse. Meanwhile we extend our most cordial congratulations to the author for having won this signal distinction in the field of the professional historian.

C. N. R. R.

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HEREDITY AND THE ASCENT OF MAN. By C. C. Hurst. Cambridge. (The University Press, 1935.) Pp. ix+136. Price 3*s*. 6*d*. net.

Human history is in reality only a special aspect of natural history, dealing with the succession of events having to do with the human species. It is continually asked, what has man been doing through the long ages of his existence? The answer is furnished in part by the answer to the even more fascinating question—what will he become in the ages to come? Modern research in biology has taught us that minute particles of living matter with definite composition pass unchanged from generation to generation. We have learnt further that the human individual is extremely complex and is made up of materials, which while deriving their salient traits from ancestral germ-plasm are arranged in new ways so that it is rarely possible for two individuals to come into the world with the same inheritance of living stuff. In the fifties of the last century Gregor Mendel, an Austrian abbot, discovered the fundamental unit of life and mind the 'gene', but like many a great discovery it was completely ignored by Mendel's contemporaries. It was not until the beginning of the present century that scientists accorded to this discovery full recognition, for want of which biologists found themselves confronted by well nigh insurmountable difficulties. Since then the progress of genetics has been both steady and considerable. Among the experiments whose work has contributed most to this progress, the name of Dr. Hurst stands pre-eminent, whose work *Experiments in Genetics* has been considered to be a classic in the field. The present book is a sequel to this more elaborate work, and is a very popular epitome of the recent work and achievements of the geneticists.

The book is devoted to a description of the fundamental unit of life and mind—the gene—which is the determining factor in the behaviour of all living organisms. Authority is implicit in this narration inasmuch as the author is a man of science and of recognised authority. The enthralling story of the evolution of living things is told in plain and simple terms making it intelligible to the lay reader. An unique feature of the book is that interesting speculation is set forth concerning the future of the human race. The author by a consideration of experimental facts comes to the universally interesting conclusion that the genetical work of the past few years may bestow freedom and power on man to shape his destiny. This sounds in striking contrast to the classical saying that "there is a Divinity that shapes our ends". Another thesis of especial interest to the statesman is that the nation which adopts scientific methods of race improvement will inherit the earth. Recent events in countries such as Germany, Turkey and Italy, under dictators, have at least in part justified this claim.

It is impossible to emphasise the importance of genetical science to the horticulturist and the breeder, but the aim of the author in this book seems to be to attract the man-in-the-street whose interest in this subject must be aroused and inspired to pursue the study at greater length. It will not be too much to expect that the volume will make an instant appeal to all those who wish to acquaint themselves with what is going on in one of the most rapidly progressing branches of biological research which has done so much to change the order from natural selection to human selection and enabled man to take a hand in creative evolution.

C. N. R. R.

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COSMIC RADIATION. By Prof. P. M. S. Blackett. Part I—General Survey. 22 pages. Price 10 *fr*. Part II.—The Wilson Cloud Chamber Method. 24 pages. Price 8 *fr*. Part III.—The Effect of the Earth's Magnetic Field. 19 pages. Price 7 *fr*. Part IV.—The Loss of Energy by Ionisation. 17 pages. Price 10 *fr*. (Actualités Scientifiques et Industrielles. Hermann et Cie, 6, Rue de la Sorbonne, Paris.)

These papers were read before the four conferences on Cosmic Radiation, held in

May 1934 by the College of France in Paris, and have been printed practically as read. It is unfortunate that they were not published more than a year earlier. They contain in concise form an account of the main lines of development of our knowledge of cosmic ray phenomena and would therefore prove valuable to those who wish to view this field through the eyes of one who has had a share in its development.

The introduction to the subject in the first paper begins with a quotation from an enthusiast who wrote without exaggeration: "Cosmic Radiation is a subject unique in modern physics, in the minuteness of the phenomena, the delicacy of observations, the adventurous expeditions of the observers, the subtlety of the analyses and the grandeur of the deductions."

After a very brief historical statement, there follows a correspondingly condensed account of cosmic ray intensities at various depths below the top of the atmosphere and under water in deep lakes, as measured by ionisation chamber methods. Intensity variations with time; geomagnetic latitude and longitude and their significance are discussed. It is pointed out that these data leave little room for doubt that the primary rays are electrically charged particles. Results obtained by means of counter-tube controlled cloud chambers are discussed in a little more detail and the paper ends with an all too brief consideration of the origin of this mysterious radiation.

The second paper should be of special value to those who wish to do experimental work with cloud-chamber apparatus. It begins with a discussion of the formation of tracks, their width, number of ions per unit length, and other matters. A few details of construction of apparatus used by the author are given. The latter half of this paper is devoted to a discussion of the production of "showers" and "bursts", investigated chiefly by means of Geiger-Muller counter-tubes.

The author shows that observations are best explained by assuming that electrically charged primary rays of high energy, in their passage through matter, produce at intervals, along their paths, a non-ionising radiation of the gamma-ray type, which in turn is absorbed with the emission of positive and negative electrons which ionise all along their paths. The production of a relatively small number of these tertiary rays at one time is called a shower but, occasionally as a result of some catastrophic process, millions of these tertiary rays are produced and this is spoken of as a "burst". It is not clear that these two phenomena are of exactly the same type. In all cases it seems certain that practically all the energy involved in these phenomena comes from the primary particles.

The subject-matter of the third paper is especially important because it shows very conclusively that the primary radiation consists chiefly of electrically charged particles, most of which are positive. The author deals at some length with the theoretical work of Störmer and of Lemaitre and Vallarta, *i.e.*, with the motion of high-speed electrons and protons in the magnetic field of a di-pole, the earth. Observational results, in the light of theory, indicate clearly that only a small percentage at most, of the softer portion of the penetrating radiation can possibly be of terrestrial origin, while all of the harder rays must come from beyond the confines of our own galactic system. Thus the term "cosmic radiation" seems to be fully justified.

The fourth paper deals with the various processes by which the energy of a cosmic ray particle is dissipated while passing through matter. The cosmic ray may (*a*) cause excitation or ionisation by passing near an electron in matter; or (*b*) directly hit an electron giving rise to a secondary high energy ray; or (*c*) make a direct collision with an atomic nucleus, resulting in the production of many high-energy photons, as mentioned above, and probably other complications.

For process (*c*), the effective area of cross section is only a small fraction of the area of the nucleus of the atom concerned, while in the absorption of the photons, the effective area is proportional to the atomic number, which in the case of heavy elements is many times greater than the area of cross-section of the nuclei.

In such papers as these it is of course impossible to give details of construction and use for the many types of apparatus mentioned. For such information and indeed for any serious study of the subject a bibliography listing more than a hundred well-selected papers is appended. Another worthwhile feature of this work is a set of fifteen excellent reproductions of some remarkable cloud-chamber photographs by C. D. Anderson and of several by the author.

J. M. BENADE.

LES SPECTRES DES NEBULEUSES GAZEUSES. Par P. Swings. (Actualités Scientifiques et Industrielles. No. 241, 1935.) Pp. 1–26 Prix. 10 *fr*.

This is perhaps one of the smallest volumes in the Actualités collection running to twenty-six pages only out of which 15 pages are devoted to a table, two appendices and the title pages. It is remarkable that in the remaining short space of 11 pages the author should be able to present such a clear and up-to-date account of the subject. This has been made possible because in the first place the author himself has done, in collaboration with B. Edlén, very important work in this field and in the second place there already existed the beautiful article of Bowen (*Ap. J.* 1935, 81, 1) giving a synthesis of the ideas on the subject.

The author treats fully the mechanism of excitation consisting of primary process of ionisation by absorption of stellar radiation and the secondary processes of ionisation by secondary radiation, excitation by the same and excitation by secondary electrons. On the other hand, the treatment of that part of the subject dealing with chemical composition must certainly be considered to be inadequate although the author has given a resumé on p. 16. It might be remarked, in passing, that this resumé reads almost like a literal translation of the first paragraph on page 16 of Bowen's article mentioned above.

B. S. M.

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DE'NOMBREMENTS D'E'TOILES. Par H. Mineur. (Actualités Scientifiques et Industrielles. No. 225. 1935.) Pp. 1–56. Prix. 15 *fr*.

This volume forms, as the author states in the preface, an indispensable complement to the volume on the measurement of positions and magnitudes of stars which has already been reviewed in these columns (*Curr. Sci.*, 1934, **3**, 223). The attempt to condense in a short space the very latest work done in the field has resulted in making the treatment necessarily sketchy and the material is not presented in a logical sequence as was done in the author's volume on "Photographie Stellaire". There is neither a table of contents nor an index nor a bibliography.

The work is, however, quite authoritative and there are no errors of a serious nature. The large number of tables and graphs interspersed throughout the volume adds much to the clarity of the exposition. Of particular interest is the representation, by means of formulæ, of the number denoting stars more brilliant than magnitude m, as based on the work of Chapman and Melotte, Van Rhijn and Seares. As a preliminary to the actual subject of star counts, the author has briefly reviewed the principal star catalogues and charts and assessed their relative importance from the point of view of Stellar Statistics. Importance has rightly been given to the Harvard photometric sequences, this being the source on which the author mainly relies.

This is an indispensable book for an astronomer, theoretical or practical.

B. S. M.

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PHENOMENES D'INTEGRATION DANS LES CULTURES DES TISSUS. By B. Ephrussi. (Actualités Scientifiques et Industrielles. Hermann & Co., Paris, 1935.) Price 8 *fr*.

Tissue Culture, undertaken mainly by workers on Cancer Research, has, in practice, involved the solution of many problems of General Biology. One such problem, as Vogt puts it, is "the individuality of cellular culture....... After several transplantations what type of formation is represented by a culture of fibroblasts?...... Is it a Unity like that of the whole organism or a part of the organism?" We venture to paraphrase it in common language as follows: Is it (the culture of tissue cells after several transplantations or passages) a chip of some block or are there as many blocks as there are chips or cells? Albert Fischer, the author of the best book on Tissue Culture, so well qualified to speak on such a problem, says in one of his papers, "The transplanted tissue obeys all the laws of physiological integrity....... We are here dealing with a partial organism and not with cellular organisms." The reasons for such an opinion have been based on certain differentiations which appear among cells on culturing a tissue. For example, the epithelium of the Thyroid begins to form the colloidal substance only in the centre while the cells on the periphery of the same culture continue to multiply undifferentiated. M. Ephrussi rightly compares a culture of tissue to an organism, for cells sometimes show division of labour even though the main function leading to the division of labour may not be apparent; he calls this oriented heterogeneity. He summarises the following points of identity between the

culture of tissue cells and an organism as a whole: (1) The tendency towards a definite shape. (2) The limit of sub-division (for single cells of tissue do not grow). (3) The power of regeneration which naturally regulates the shape. (4) Oriented heterogeneity. M. Ephrussi further finds two problems common between the science of Tissue Culture and General Biology: (1) What limits the growth of a tissue in culture? and (2) What determines the development of a cell? That there is a regulating factor inherent in a culture of tissue is inferred by the presence of a similar substance in a colony of Vorticella as previously shown by the renowned French Biologist, Faure Fremier, under whose editorship the present brochure has been issued. Such a substance, although hypothetical at present, is probably also found in an egg where it regulates the growth of the embryo. M. Brachet has called it "Genetine". M. Ephrussi has given a clear exposition of the subject within 22 pages of printed matter using some 10 diagrammatic figures for illustrating the important points. For the modest price of 8 francs nothing more could be expected but many a reader would have welcomed a longer essay perhaps with some microphotographic illustrations which would have given a more realistic representation of the phenomenon discussed so ably by the author. The subject appears to be of very recent origin, for no paper in the bibliography dates earlier than 1922.

S. M.

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HEAT. By Hutchinson. (University Tutorial Press, Ltd., London.) Pp. 284. Price 3*s.* 6*d.*

This is an excellent work by a well-known author and fits in admirably with the Intermediate syllabus of Indian Universities. The chapter on "Radiation" is the only chapter where the author could have adopted a fuller treatment by the addition of the "Theory of Exchanges" and Richie's experiment.

A historical background is provided throughout the book by detailed description of classical experiments. The utility of the book is greatly enhanced by the mention of all the practical applications of heat in industries and engineering. Heat engines have received particular attention in the last chapter.

The worked and unworked examples are as interesting as they are varied in type. Solutions to the examples are, unfortunately, omitted and would be a welcome addition to the book.

One cannot help wishing that the cover of a book, whose get-up in other respects is excellent, were of a different colour. The bright orange cover "strikes" one in the eye. Would not a light green or blue be more suitable for a study?

P. A. MADHAVA RAO.

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ORGANIC SYNTHESES. Vol. XV. Edited by W. H. Carothers. (Messrs. Chapman & Hall, London, 1935.) Price 8*s.* 6*d.* net.

The book under review is the fifteenth member of the series of publications entitled "Organic Syntheses". The present one contains description of usefully workable methods of thirty different preparations. The inclusion of substances like 5 : 5-dimethyldihydroresorcin, diazomethane, 2 : 4-dinitroaniline, *p*-iodophenol, 1-methyl-2-pyridone, etc. and an experiment describing the preparation of anhydrous hydrogen bromide, obtainable continuously for hours, make the book quite useful. Amongst the types of reactions dealt with in the present volume are to be found examples of (1) addition of hydrocyanic acid to a ketone, (2) substitution reactions, (3) reduction with tin and hydrochloric acid, (4) Grignard's reaction, (5) malonic ester condensation, (6) decarboxylation with concentrated alkali at high temperature, (7) halogenation with halogen acids, and (8) oxidation with selenium oxide. The get-up of the book and the disposition of the contents are exactly as in the previous volumes.

P. C. GUHA.

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LABORATORY MANUAL OF PHYSIOLOGICAL CHEMISTRY. By Prof. Meyer Bodansky and Marion Fay. Third Edition. (John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1935.) Pp. vii+274. Price 10*s.* net.

This is the laboratory companion to Professor Bodansky's well-known *Introduction to Physiological Chemistry* (*cf.* review in *Current Science*, 1935, **3**, 318) and the latter should be consulted at every stage to understand the bearing and significance of the experiments dealt with. As an elementary laboratory manual useful to students preparing for a degree in Medicine, the book serves a real need. It comprises both qualitative and quantitative experiments, systematically arranged. The subjects dealt

with are few, but vital and within the limits imposed by the size of the manual; the authors have succeeded in placing before the readers, a comprehensive array of the salient features of physiological chemistry. While the book cannot lay claim for completeness, it serves as an excellent introduction and if supplemented by collateral reading of easily accessible literature with the assistance of the references cited throughout the book, the student cannot fail to obtain a working knowledge of the subject.

The get-up of the book is excellent and leaves nothing to be desired. We are confident that the revised edition will receive a warm reception.

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INSECT PHYSIOLOGY. By V. B. Wigglesworth. (Methuen & Co., London.) Pp. viii + 134 with 13 Illustrations. 1934. Price 3*s*. 6*d*.

This little book maintains the high standard reached by other monographs on biological subjects published by Methuen & Co., Ltd. It will be welcomed by the agricultural and medical professions and will be of great value to students of general zoology. The general physiology of the group of Insects which are the most numerous in species and the most varied in structure and habits, is apt to be observed by the practically endless specializations of these animals, but the author has retained only the material points, linking all the general factors into a single system, in illustration of his theme.

Though the early scientists like Hooke, Malpighi and others have studied the morphology of insects and have given us correct and valuable information about their physiology, the subject did not receive further attention nor any impetus till entomologists were confronted with the ravages caused by the insects in the spheres of agriculture and public health. Subjects like responses to stimuli, reactions to parasites, acclimatisation and the action of toxic sprays and gases upon these, have engaged the attention of economic entomologists within recent years. We, therefore, congratulate Dr. Wigglesworth and welcome his largely illustrated monograph in which the author says that "the sketch which follows is based on the study of nearly 2,000 publications, and on a certain amount of original work".

The first chapter deals with the integument and it is very well known that a large amount of insect physiology depends upon the nature of its cuticle. The cuticle which consists of thin epi- and a thick endo-cuticle is shed from time to time. The unimpregnated endocuticle is very elastic and this is proved by the fact that the first stage larva of Rhodnius can receive into its abdomen more than 12 times its own weight of blood. During moulting, a large part of the cuticle is dissolved; the endocuticle when unimpregnated with cuticulin undergoes dissolution, when the epicuticle remains untouched. Possibly this digestion of the cuticle is brought about by the secretion of enzymes (a chitinase or protease) by the dermal glands into the moulting fluid present between the new and old cuticle. The epicuticle is torn by the pressure of the blood. Chapters II and III deal with the respiratory and circulatory systems. The diffusion theory of insect respiration is briefly described and an account of the respiration in aquatic forms like Hydrophilus, Dytiscus (metapneustic respiration) and Notonecta is given, and among parasites mention is also made of the aquatic larva of Donacia possessing special siphons which are inserted into the air-containing tubes of aquatic plants, and thus remain submerged permanently. The wounds in many insects are merely closed by a plug of cells and the blood does not clot in that region. The blood-cells or hæmatocytes are phagocytic and accumulate on the sides of the dorsal blood-vessel forming phagocytic organs.

In the chapters on digestion and excretion, besides giving important and interesting information regarding salivary glands, the author has given excellent description of digestive enzymes, Malpighian tubules, the holocrine and merocrine types of secretion. The former is a cellular disintegration to form the juice while the latter is merely a secretion from the epithelium.

The next two chapters deal with nutrition and metabolism, and reproduction and growth. The importance of symbiotic organisms is discussed in insects like Cimex, Glossina and Pediculus. With regard to the subject of metamorphosis, it is believed that this is initiated by a harmone which is different from the one responsible for moulting.

The last chapter gives an account of the nervous system, sense organs and behaviour. There is a large list of references given at the end of the book so that students requiring detailed information may refer to the original papers. The get-up of the book

is neat and attractive and we have no doubt that it will be appreciated by the scientific workers for whom it is intended.

L. S. R.

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HELMINTH PARASITES OF THE DOMESTICATED ANIMALS IN INDIA. By G. D. Bhalerao. (Scientific Monograph No. 6 of the Imperial Council of Agricultural Research.)

The study of helminthology has, in recent years, revealed its importance not only in medicine and public health, but also in veterinary and agricultural sciences. Unfortunately this branch of science has, till recently, been neglected in India. Mr. Bhalerao's Monograph on the "Helminth Parasites of Domesticated Animals in India" has adequately put forward its claims in veterinary science and is a valuable asset to the helminthologists and veterinarians alike. The aim of the monograph is to provide a collective account of the helminth parasites of our common domestic animals and to facilitate their identifications. Each helminth group—Trematoda, Cestoda, Nematoda and Acanthocephala—is considered separately, beginning in a general way with the morphology and life-history, followed by a systematic account of the group under review. Elaborate keys for the identification of the parasites belonging to each group form very useful part of the work. The descriptions, though concise, are suitably illustrated by clear diagrams, many of which are claimed to be original. The bibliography given at the end of the book is exhaustive and renders the volume of service even to advanced workers. The author has successfully achieved his object and the work compares favourably with any other in the field.

No work of this kind can be perfect in every way and there is always a danger of its becoming out of date, even prior to its publication, especially when continued research is daily adding new forms to the helminth fauna. There appear to have been certain omissions and unfortunate errors in this volume. The author has been rather modest in omitting his important forms described in recent years. In the interest of the subject, these and certain others described by other authors from India ought to have been included in the book. Mention of the presence of receptaculum seminis in the family Psilostomidæ is rather curious, as its absence has been emphasised in many standard works (*vide* Führmann in Kükenthal's *Handbuch der Zoologie*). There are some slips as well and these though trivial, are blemishes in an otherwise admirable piece of work.

The general get-up of the book is nice and the paper used is good. The book is particularly welcome as it comes from the Research Staff of the Imperial Institute of Veterinary Research, Muktesar, where most of the officers of the Veterinary Department now complete their training. Mr. Bhalerao is, therefore, to be congratulated on this successful venture of a zoologist. The book is the first of its kind from India and will undoubtedly well serve the purpose intended. It should meet the requirements of both the student and the practising veterinarian, and would, besides, form a useful addition to the zoological libraries.

G. S. T.

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FUNDAMENTAL PHYSICAL PROPERTIES OF LAC—PART I. MECHANICAL PROPERTIES. By Lal C. Verman. (Technical Paper No. 3. London Shellac Research Bureau.) Pp. 28.

This neat brochure heralds the publication of a series of four dealing with various aspects of the Fundamental Physical Properties of Lac, *viz.*, Mechanical Properties, Thermal Properties, Electrical Properties and Optical Properties. It was pointed out by Mr. Gibson, sometime ago, that, among other things, compilation and publication of exact data on the Physical, Chemical and Mechanical Properties of Shellac, with special reference to use in industrial processes, would go a long way to consolidate the position of lac as a raw material in industry ; Dr. Lal C. Verman has taken great pains to collect and collate the floating facts and present them in such a concise form for ready reference. After a brief outline of the methods and their limitations, values are given for the specific gravity of shellac, film-hardness, adhesive strength, ultimate tensile strength and modulus of elasticity of various types of shellac and shellac compositions. Wherever possible the corresponding values for other natural and synthetic products are also given for comparison.

A perusal of this booklet brings to light certain striking properties of lac which can be turned to commercial exploitation. The removal of the wax from lac seriously impairs the scratch-hardness and abrasion resistance of shellac films, and the author's own work indicates that the natural wax is far superior to added plasticisers in conferring hardness and especially abrasion resistance

to shellac films. It has been clearly pointed out that the hardness of the film depends on the nature of the base to which it is attached and the subsequent baking. Another remarkable property of lac brought into strong relief is that its adhesive quality is something enormous compared with fish glue and gelatin, the drying period being relatively negligible at that. In spite of this the film produced from shellac varnish can be "flatted" by sand-paper. An adequate bibliography at the end considerably enhances the usefulness of this brochure.

This publication is all the more welcome at this juncture when lac is faced with a crisis. By bringing to the fore the outstanding qualities of lac, it may help the lac industry to hold its own against the onrush of synthetic products. It is hoped that, ere long, the other parts also will come in print.

A. V. S.

* * *

INDIAN SUGAR INDUSTRY (1935 ANNUAL). By M. P. Gandhi, Secretary, Indian Sugar Mills Association; Secretary, Indian Chamber of Commerce, Calcutta. (G. N. Mitra of Messrs. Book Co., Ltd., 4/3 B, College Square, Calcutta.) Pp. xvi + 57 + 22. Price Rs. 2–4–0 (postage extra). Foreign *7s. 6d.*

At the time when the Indian Sugar Industry is making rapid strides of advance under the Government's protection policy with all its beneficent influence on the agriculture of the country, this publication by Mr. M. P. Gandhi must be of immense interest to industrialists as well as to the general public. The author has presented briefly all sides of the industry and its inherent problems. The earlier part of the book contains tables of all the necessary data about production, exports, imports, costs, consumption and many other pertinent topics. The main text confines itself to a detailed explanation of practically the same topics with the author's views and arguments. The reader has herein an opportunity of knowing a short history of this important industry, its present position and the future possibilities.

The fifteen tables inserted in the book are useful as permanent references because they include besides the figures for the year under consideration those for several of the preceding years and also here and there estimates for the coming years. The appendix contains an outline of world sugar industry with a special section on Java. The monograph ends with a very useful list of all the sugar factories in India.

For purposes of easy comparison quantities must be expressed in the same unit, for example, as tons or as maunds and though it is appropriate to use both the units it will make comparison of data more difficult. We find also different ways of numeration adopted even in one and the same table as for example in Section (9) of "The Indian Sugar Industry at a Glance" where the quantity of cane crushed is expressed as lakhs of tons and other quantities as millions of tons. Attention to these small details is bound to enhance the value and usefulness of the work.

It is hoped that the author undertakes this publication every year for the use of the public who are interested in the welfare of one of our important national industries.

G. G. R.

* * *

CANDLE MANUFACTURE. By Professor Dr. N. N. Godbole, assisted by R. N. Mehta. (Benares Hindu University, Benares, 1935.) Pp. iv + 29. Price Rs. 2. Foreign *4s.*

This small book of 29 pages embodies the practical experience of the authors in the industrial laboratories of the Benares Hindu University and also includes information collected elsewhere.

The first chapter presents a brief survey of the historical and economic aspects of the industry. The raw materials of the industry are described in the second chapter, which gives in addition an elementary idea of the process of the "splitting" of fats and hydrogenated oils. Auxiliary materials such as ceresine and bees-wax as well as the recently developed I-G waxes, and their assistance in the manufacturing process are indicated in the fourth chapter.

A short account of preparation of candle-wicks and the significance of the melting and congealing point of candle-material is followed up by a very brief description of the manufacturing process as carried out with modern machinery. Some hints are also given regarding the manufacture of fancy material such as coloured, medicated or perfumed candles.

The tables given in the appendix contain information concerning (1) size of wick and diameter of candle, (2) shape, size and weight, and (3) melting points of some types of candle-material.

It is hoped that this book will be read by all persons interested in candle manufacture.

UNIVERSITIES YEAR BOOK, 1935. Published for the Universities Bureau of the British Empire. By G. Bell & Sons, Ltd., London, 1935. Pp. xxxi+1057.

The latest edition of this well-known year book has all the merits of its predecessors, authoritative character, comprehensiveness and excellent get-up. First published in 1914, the Year Book has become more and more indispensable to the members of universities and colleges, government departments, clubs, school masters, etc., who find in it much information of interest regarding members of other universities, colleges, etc. The publication has been brought up-to-date and the arrangement of matter is so designed as to make ready reference possible and in this, considerable assistance is afforded by the excellent name and general indices.

Each section under Universities (of Great Britain and Ireland, of Canada, of Australia, of South Africa and of India) comprises a directory of the officers and members of the staff of the universities, general information and reports of events of outstanding interest which occurred during the previous year. There are 31 appendices, which provide such varied information as professions and careers, post-graduate scholarships, centres of scientific and industrial research, etc. Considerable space is devoted to Indian universities not only in the earlier chapters, but also in the appendix. The publication is indispensable to all libraries where it will occupy an important place among reference volumes.

* * *

LES ASSOCIATIONS BIOLOGIQUES AU POINT DE VUE MATHEMATIQUE. By M. Vito Volterra and M. Umbreto D'Ancona. Pp. 97, 28 Figs. (Actualités Scientifiques et Industrielles. Hermann & Co., Paris, 1935.) Price 20 *fr*.

This brochure is a guide to the study of the rise and fall of population among animals and lower organisms by the application of mathematics. The late E. F. Smith, the author of *Bacterial Diseases among Plants*, who has done more than any one else to increase our knowledge in this branch of science and as such deserves to be considered a great biologist, says in his book, "Nothing is more discouraging to the general reader than a book or paper full of mathematical formulæ." He further writes, "Biologists, for the most part, are very far from being able to express themselves after the manner of mathematicians. Their language and ours is unlike almost to mutual exclusion. If your liking for mathematics is second only to your love of biology, then you may study it as long as you feel inclined. You will be a kind of white blackbird among your fellow biologists but this need not disturb you since you will be able to do some things which they cannot do." If any ambitious biologist wishes to make himself such a "white blackbird", he cannot do better than start with the work of Volterra and D'Ancona under review for it gives as easy and simple an introduction to the subject as possible. Volterra's mathematical theory of the struggle of life has proved of such significance that it has offered others like Gause and Severtzoff material to elaborate on. Master of his field Volterra's treatment of the subject can hardly be surpassed in lucidity and selection. However, as the authors themselves state, their publication, on account of its small size, can hardly serve as anything more than a guide and they refer the interested reader to other literature in the bibliography. Here we note several serious omissions. E. Fischer's name occurs in the text on p. 82 but none of his papers is listed at the end of the book. At the University of Oslo, Prof. Hjort, collaborating with Drs. Ottstad and Klem, has made a mathematical analysis of yeast growth as a model of increase in population and applied this and similar results to study the fluctuating population of the whale. These three Norwegian scientists have published excellent "Essays on Population" in 1933 but no reference is made anywhere to thei work. Influenced by the application of mathematics to the study of insect epidemics, H. E. Prof. Escherich, the present Rector of the Munich University, has explained "The New Aspect of Forest Entomology", in *Forstwiss. Cen.*, 1930, Heft 12; while from his Institute Prof. Zwölfer has published several classical papers, among others a mathematical essay entitled, "The Theory of Insect Epidemics", *Biol. Zentr.*, 1930, Bd. **50**, Heft 12. These papers also appear conspicuous by their absence. Like most French books the publication under review is an inexpensive one and Messrs. Hermann & Co. have the readers' thanks at the fine get-up and the absence of all errata.

S. M.

The Structure of Metallic Coatings, Films and Surfaces.*

THE papers read at a symposium on this subject conducted by the Faraday Society and the discussions thereon appear in a special number of the *Transactions of the Faraday Society*. A number of well-known workers in this field have taken part and in all there are about thirty papers.

In Part I, Professor Finch and his collaborators have given a complete account of the study of surfaces by electron diffraction methods. Their paper surves as a valuable monograph for workers in this field. It is made quite clear that although there are still a few points to be cleared regarding the interpretation of experimental results, the method of electron-diffraction is probably the most powerful available for the study of surfaces. The evidence given by this method towards the clarification of the "vexed question" of the Beilby layer on polished surfaces is in favour of the existence of such a layer. In the general discussion on this problem Professor Kirchner makes the observation that diffuse bands of the type given by polished surfaces can also be obtained by reflection from suitably prepared, sputtered or evaporated films which however give sharply defined rings by transmission. But sputtered or evaporated films and the polished layer are two different things which are not directly comparable, and thus the evidence against the existence of the Beilby layer is not overwhelming. Hopkins finds that the Beilby layer is about 30 Å thick while Zees finds a layer of oriented crystals separating the Beilby layer from the polycrystalline layer underneath.

In the second part there is a very interesting paper by Professor Andrade, incorporating some remarkable results obtained by him recently. He has followed various stages in the growth of crystals in thin films of silver on heat treatment, by microscopic methods. Spherulites, *i.e.*, uniaxial crystal fibres radiating from a centre, are first formed on heating such films. These gradually grow into single crystals with their 111 planes parallel to the surface of deposition, on increasing the temperature. This observation is in agreement with the results obtained by previous workers by X-ray and electron-diffraction methods as to orientation of crystallites in metallic films on heat treatment.

The remaining papers deal with metallic coatings obtained by electro-deposition, hot dipping and spraying. Macnaughton and others present the results of a study of the hardness of electro-deposited nickel in relation to grain size, *p*H value of the electrolyte, etc. Blum and Kasper find that deposits obtained with nickel chloride solution are fine-grained and relatively smooth, strong, hard and brittle. Those obtained with sulphate baths are rough, coarse-grained, soft and ductile. Professor Kohlschütter's paper on "Somatoids" is valuable in understanding the formation of abnormal growths on the cathode during electro-deposition. Hothersall has studied the influence of the substrate on the structure of metallic coatings obtained by electro-deposition. Wood has made a thorough study of the differences between electrically-deposited metallic coatings and the normal metal by X-ray methods. He finds a broadening of the lines in the X-ray diffraction pattern of such deposits of nickel and chromium and points out a correspondence between this line broadening and the hardness of the deposit. He also finds that the brightness of the deposit was greater in the deposits showing more perfect orientation of the crystallites than in others.

The papers and the discussions which follow them provide a more or less complete survey of the subject. The discussions especially are highly stimulating and in them several interesting points are raised which may form subjects for further work. It is clear from a study of these that the method of electron-diffraction is invaluable for the examination of the structure of surface layers. But other methods involving the use of X-rays, optical properties of the surfaces and microscopic studies are also essential.

S. R.

* *Transactions of the Faraday Society*, 1935, **31**, Part 9*a*.

1705-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.

Over-Population in India.

IN an extensive note recently published in the press, the Public Health Commissioner with the Government of India was reported to be contemplating a discussion of the problem of over-population in India in an article about to appear in the *Indian Medical Gazette*, and also as making a suggestion, that the Federal Administration should deal with the issue of family limitation as a remedy for combating the baleful consequences, resulting from an uncontrollable increase of population. In many provinces large masses are at the level of bare subsistence, with hardly any clothing or house furnishings but possessing quite a remarkable power of fecundity. Few will fail to be impressed by the prevailing misery, squalor and poverty of the Indian people, and among the numerous public matters with which the Government of India will shortly be confronted, the subject of raising the economic level of the country and of improving the standard of living of the common people must necessarily occupy the foremost place.

Modern civilisation is full of paradoxes. In the midst of plenty people are allowed to suffer. The banks are embarrassed by a plethora of money, but are unable to release the funds for providing relief to the unemployed. Gold always regarded as an incorruptible standard of currency, has been deflected from its appointed task, with the inevitable effects of discouragement and arrest of business involving human unhappiness. Increase of population considered a sign of public prosperity in the past, has now become a menace. These strange and alarming phenomena in human affairs must inevitably puzzle the ingenuity of all Governments, and perturb the hearts of public leaders. It seems to us that at the root of all these troubles lies the currency problem. The recent policy of sovereign governments of hoarding gold and silver is obviously due to the apprehension of a shrinkage in their supply, and their immobilisation paralyses trade and increases unemployment. If the world would adopt a form of currency, incapable of maldistribution or of being cornered, which could be used purely as a counter or a cheque between services and commodities, perhaps the other social problems might admit of easy solution. It is the inefficient system of world economics that has made some of the existing population superfluous, and the

remedies suggested for restricting the increase are in the nature of an experiment in human biology.

We know that the humanitarian measures, which governments and voluntary public services have adopted for the promotion of the peoples' health and happiness, provided also the causes leading to an absolute increase of population. But no one can seriously suggest the suspension or repeal of all attempts at sanitation and the prevention of disease, the provision of famine relief measures or the protection of the person and property of the people as one of the remedies for over-population. It may be possible to absorb the superfluous population by an extension of irrigation, improved methods of agriculture, emigration and closer settlement of sparsely inhabited lands and by developments in industry and commerce. The limits of what can be done in these directions must be reached sooner or later, and possibly in most parts of the world they must have been already reached. It is legitimate therefore for public leaders to suggest the popularisation of contraceptive technique as an infallible remedy for limiting the number of births, and every child knows that population of manageable dimensions can have more food, better accommodation, higher expectation of life and greater facilities for racial improvement.

Scientists may soon be in a position to estimate exactly what human population India can carry at a tolerable level of existence, providing for freedom, happiness and all the richness and variety implied in a full and complete life. Till we get an idea of the estimated maximum population, the term over-population must continue to be used as a vague one, for reckonings based on insufficient assumptions can have very little practical value. It has to be borne in mind that the numbers of human population alone do not press steadily on the means of subsistence, a large percentage of which being destroyed by other species of animals. Further a large quantity of food good enough for human mouths goes to support stray animals and domestic pets, apart from what is thrown away as waste. We can fairly comprehend the total volume of food consumed by the larger mammals, rodents, birds and insects in the wild state, and by other animals which hang on the outskirts of society rendering little service. We practically ignore the loss of food due to animal depredations when we describe over-population as signifying that in a given area at a given time there are more people than the produce of land can support in a reasonably comfortable existence. We are not pointing to this source of loss as an argument against the suggested remedies for controlling over-population, and we are fairly certain that all the forces arrayed against the general practice of contraceptive methods will be utterly futile to check its progress, for the knowledge relates to an imperious biological process, which interests mankind more than food. In any sphere of human thought and action, freedom without responsibilities is dearly coveted by every one, and critics of birth control point out that the doctrine of the Malthusian League favours such freedom. They desire to know whether the dissociation of freedom and its attached responsibility in society will favour its refinement and ennoble its conscience, where such alienation in the political sphere is apprehended to lead to anarchy. They ask whether the effect which the cause is prevented from producing, will not manifest itself in some other form, or whether in Nature or in the human system, an act can be perpetrated without entailing appropriate consequences. No doubt the advocates of birth control must have thought about such questions and must have satisfied themselves that the practice, which they seek to popularise, is not limited to the single problem of food, but that it really embraces all the aspects and spheres of human existence.

The population of India is about 19 per cent. of the total population of the world, and the rate of increment from 1872 has been 23·2, 13·2, 2·5, 7·1, 1·2 and 10·6 per cent. The actual increase, according to the latest Census Report, since 1921 is 33,895,293 which represents 10·6 per cent. at the last census, and more than 39 per cent. on the population of India fifty years ago, and an increase of 12 persons per square mile in 50 years, during which time the increase in area has been principally, if not entirely, confined to comparatively thinly-populated areas, amounting to 426,055 square miles. During this period the birth rates of various European countries have fallen, England and Wales 36·3 to 17·8; Germany 40·9 to 20·7; Italy 39·2 to 27·8 and Sweden 30·8 to 16·9. There are many interesting subtleties regarding the statistics of population, and according to the computations of American authorities the total optimum population of the world is

lions, which is less than the population India. The optimum population of any intry must depend largely on the standard life, and as there is every need for sing this standard in India, it is obvious it its present population is far above the imum. India is passing through the ning phase of rapid multiplication, tered by modern industrialism such as urred in the European countries from first appearance of factory manufacture the eighteenth century upto the seventies the nineteenth. Indian leaders are of nion that her prosperity depends upon lustrial expansion more than on her icultural pursuits, and that the country ould cease sooner or later to import foreign nufactured articles. This decision inves the reproducing in all factory centres identical conditions which led in the ropean countries to the enormous increase their population. We have to add to h conditions the elimination of all natural eks upon the numbers of a less organised nmunity with little education and a poor ndard of living. The minds of people not troubled by what is known as the oid multiplication of the unfit and by their n relative poverty. The message of birthtrol is a far cry to them, and their education and religious principles have not sufficntly fortified their minds to practise stinence and self-control. Judged by gross conditions in which the poorer nmunities live, a further increase in the al population of India seems inevitable.

Recent authors on the population problem India have drawn attention primarily to question of food production. The gument is that the population of India is eady living permanently on the verge of rcity, and any addition is bound to result an insufficiency of the food supply. The vocates of birth-control emphasise that men who bear numerous children are bjected to miseries, that they lose their serve vitality, and that the children are dernourished and are indifferently eduted. We are not dealing here with the question of maximum population possible in India, t with the other question of maximum pulation desirable, and in this connection is essential to have an accurate estimate the degree to which the recent rise in mber has taxed the ability of the country support its occupants at a reasonable stanrd of living. The position of the econosts in the European countries now appears to be that even if the low birth rate is reversed to former proportions, the rapid development that is taking place in the world production of food would be adequate to meet any such increase. It is doubtful whether, within the next decade, the production of food in India, in spite of rapid researches in the mechanical and biological fields of agricultural occupations, will be sufficient to cope with the increasing numbers. Nevertheless it is reasonable to suppose that the general adoption of improved and intensive methods of cultivation might result in an increased output of at least 30 per cent. throughout India. If in the total cultivable area the process of raising crops was brought under scientific control, and if by any chance the present population of India was not allowed to increase, there can be little doubt that the standard of living of the masses would rise rapidly. But the apprehension is that the population shows a tendency to multiply, unless the law which governs increase is artificially suspended. Is this apprehension based on any scientific theory?

Those who have investigated the population problem point out that this inevitable increase need not necessarily bring misery in its train, since "the orderly evolution of human knowledge justifies us in assuming that science will keep pace in discovering means of expanding opportunities of happy human existence", and the human organism is endowed with the power of adapting itself to an extent not yet imagined. Even if the existence of any community is threatened by an uncontrollable multiplication of its numbers beyond the means of subsistence, Nature has sufficient reserves in maintaining the balance by governing the ratio of fertility unassisted by any extraneous intervention. That Nature has not relinquished her laws of maintaining a definite relation between the maximum desirable population and the means of subsistence is illustrated in the case of the Arab population of Algiers, who show both a decrease in the birth rate, which could not be ascribed to any voluntary practice of contraceptive technique, and a decrease in the death rate which equally could not be ascribed to improvements in public health measures. Attempts to effect a retardation of the rate of increase by voluntary limitation of the birth rate because of the diminution of returns from the land require closer investigation, before any scientific conclusions can be formulated.

The second argument that repeated child bearing involves misery to one section of the Indian population which, it is only human to relieve, is a powerful one, and apparently justifies the wide-spread practice of family limitation by artificial methods. In one of her recent papers published in India, Dr. Marie Stopes has pointed out that the apparatus required by the general masses will cost practically nothing and the means of prevention of conception are available in the poorest houses. The argument that man lives in an artificial society, and that his productivity must be governed by artificial means is generally acceptable, but his bodily functions remain natural and obey the simple laws of metabolism. He retains sufficient plasticity to be affected by the environment he has created for himself. It is well known that the researches of American authors on the reproduction rates of social groups have produced evidence of a negative relationship between educational advance and fertility; further it is almost a demonstrable fact that full-time paid occupations of women are found incompatible with effective reproduction in any large community. Unhealthy crowding in slums seems to raise fertility, but the rural developments which the Government of India and provincial authorities have inaugurated with the object of ensuring decent environment and attractive housing for the poorer classes, and the campaign against congested areas in populous towns must counteract forces conducive to high fertility among families least equipped for this responsibility.

We are not arguing against the new doctrine of family limitation. Its object is, however, gradually realised by the operation of those social phenomena which we have noticed. It is established by the American school of investigators with a fair measure of probability that education, occupation, better housing and a higher standard of life have individually the power of affecting more or less permanently the rate of fertility. The hope of restricting the population of India seems to lie more in the rapid and energetic promotion of those social developments which must inevitably effect fertility rate, than in the promotion of the artificial methods to which sentiment and custom are hard to be reconciled. The results in the latter case are spectacular, but those arising from the former must be progressive and slow.

English as the Common Language of India.

WITHIN the last two months there have been many notable public utterances on this subject. Vernaculars are generally favoured as the medium of instruction, and some of these languages have sufficiently developed to be adopted for this purpose. Urdu is now used in the Osmania University for imparting instruction in all the branches of scientific and humanitarian knowledge, and few will doubt its capacity to galvanise the national intellectual life. Hindi, Bengali and Marathi possess an equally rich literature, and like Urdu they possess all the flexibility and assimilative power of a virile and growing language. The vernacular press, which is an efficient instrument for instructing and interesting the masses in public affairs, has been increasing in large numbers, and, given the proper encouragement, some of them are bound to exercise a great influence on the thoughts and aspirations of the people.

Sir Martin Forster, in his illuminating presidential address delivered during the Education Week Celebrations of the Bangalore Educational ...ociation in the second week of this month, ...ed the following significant sentence from a ... addressed by Babu Rajendra Prasad to the students of Madras. The latter recognised "one great advantage in the English language and English literature which you cannot get elsewhere. The English literature is full of the ideals of freedom and liberty which Englishmen have cherished". In the Convocation Address to the Annamalai University which, for breadth of view and clear grasp of the fundamental problems, is really brilliant, Amin-ul-Mulk Sir Mirza Ismail remarked, "To my mind the antithesis (vernacular and English) is both superficial and unnecessary ....English is undoubtedly a most useful language to learn from every point of view,—social, cultural, educational and political,—and no University in India can afford to neglect it." Mr. C. Y. Chintbamani in his Convocation Address to the University of Mysore deprecated the use of English as the common language of India. Sir Mirza Ismail and Sir Martin Forster viewed the problem from a higher standpoint, when they drew attention to the value of the English language, "as a constituent of Indian National efficiency, and its relation to the share that India is destined to assume in the problem of Internationalism."

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The Ultracentrifuge and Its Applications.

By The Svedberg.
(*Fysikalisk-Kemiska Institutionen, Upsala.*)

ZSIGMONDY'S monograph "Zur Erkenntnis der Kolloide" which appeared in 1905 is to be looked upon as one of the mile-stones along the road of advance in colloid science. In this book was collected the experimental material showing conclusively that a great number of apparently homogeneous pseudosolutions or colloids are really heterogeneous in nature, being built up of small particles suspended in a liquid. The new means used for carrying out these observations was the ultramicroscope constructed by Siedentopf and Zsigmondy in 1903. By way of analogy it appeared probable that all colloids are similarly built.

The ultramicroscope, however, has two serious limitations. In the first place, it can only make visible particles the index of refraction of which differs greatly from that of the solvent (or dispersion medium, as the "solvent" of colloids is usually called). Only in especially favourable cases, such as gold, platinum and silver particles, is it possible to penetrate down to sizes of the order of $5m\mu$. The wide and important domain of lyophilic colloids, such as sulphur, ferric oxide, silicic acid, proteins, starch, cellulose, rubber, can only to a very limited extent be explored by means of the ultramicroscope. In the second place, it is to be noted that an ultramicroscopic study even in the favourable case of, say, a gold colloid, can only give rather incomplete information with regard to the statistical distribution of the various particle sizes present in the colloid solution.

Zsigmondy's monograph impressed the writer greatly when he, as a young research student, became acquainted with it. Mainly through its influence his studies were directed towards research in colloids. During these activities the limitations of the ultramicroscope became evident to him and he soon found himself engaged in a search for some other means of attack in cases where the ultramicroscope failed. The brilliant work of Perrin (1908) on the Brownian movement and the sedimentation of small particles suggested some method built on diffusion, osmotic pressure and sedimentation. It should be possible, so the writer argued, to combine these properties so as to dispense with the necessity of making the particles visible.

After some preliminary work on diffusion and sedimentation of colloids (1911) and after Odén had carried out in the writer's laboratory his beautiful researches on the size-distribution of particles by means of a self-recording balance (1916) which measured the accumulation during sedimentation in the field of gravity, the writer decided to try the possibility of studying particle-size and size-distribution curves by means of the centrifuge (1922). Earlier attempts in this direction did not seem very encouraging. The first trials made by Nichols and the writer in the chemistry department at Wisconsin (1923) showed, indeed, that this road would not be an easy one to travel along. In the first place, it was evident that all measurements had to be done while the sample was rotating at constant speed. Accordingly only optical methods could be used for recording the sedimentation. In the second place, the centrifuging had to be conducted at constant or only slightly and uniformly varying temperature. These two conditions have to be fulfilled in order to obtain convection-free sedimentation. In the third place, the centrifugal field created within the solution to be studied should be of high intensity and homogeneity.

The conditions for convection-free sedimentation were studied by Rinde and the writer (1924) using fine-grained gold sols as test objects. It was found that the sample must be sector-shaped, completely enclosed and of not too large dimensions. The friction against the surrounding gas has to be reduced and the heat from the bearings kept away. We found it possible to perform faultless sedimentation in centrifugal fields 5,000 times the force of gravity (mean radius 45 mm., height of column of solution 15 mm., speed 10,000 r.p.m.) and to measure the size-distribution in gold sols down to the most fine-grained ones. The name ultracentrifuge was proposed for this new research tool.

Using the same apparatus Fåhræus and the writer (1925) succeeded in determining the molecular weight of proteins by means of sedimentation measurements. Evidently the ultracentrifuge would be of great value

as a research instrument in the study of high-molecular compounds. Feeling convinced of this the writer decided to do his best to develop further the ultracentrifuge idea.

In 1926 F. Ljungström, A. Lysholm and the writer reached 100,000 times gravity (mean radius 52 mm., height of column of solution 12 mm., speed 45,000 r.p.m.). In the spring of 1931, further improvements of the machinery accomplished by G. Boestad and the writer made possible sedimentation measurements at 200,000 times gravity (or 200,000 g.), (mean radius 65 mm., height of column of solution 12 mm., speed 54,000 r.p.m.). Using the same radius and the same height of column of solution we reached 260,000 g. early in 1932, 300,000 g. in the spring of 1932 and 400,000 g. in the spring of 1933.

measurements made in very intense centrifugal fields using a low column of solution and a small mean radius with such made in somewhat less intense fields using a higher sample situated farther from the centre of rotation has shown that the accuracy is much better in the latter case at least as far as sedimentation velocity measurements are concerned. For a standard equipment, therefore, a large rotor is to be preferred.

From the many different experimental machines built in Upsala two standard types have been developed. The first one is adapted for the region 500 to 15,000 g., the other one for the range 15,000 to 750,000 g. The low-speed machine is driven directly by a high-frequency motor and is provided with ball-bearings. The rotation takes place in hydrogen of atmospheric pressure and the casing is immersed in a

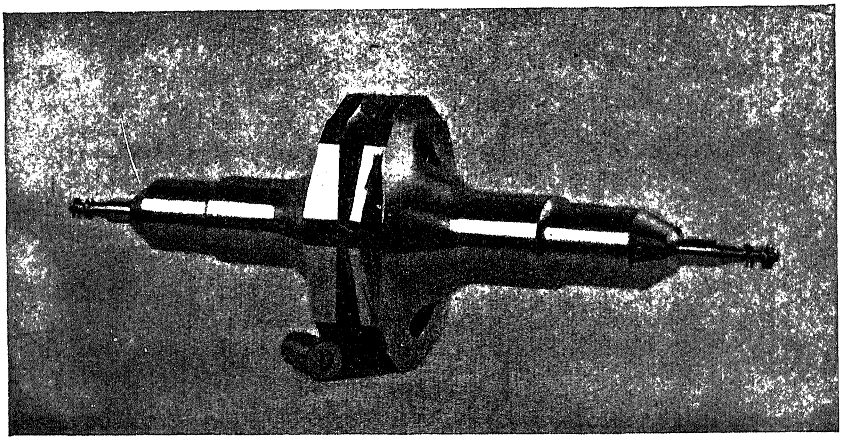


Fig. 1.

Rotor and cell for centrifugal fields up to 750,000 times the force of gravity.

Essentially higher fields cannot be utilised with rotors of this size because of failure of the material. It seemed of interest to try a smaller rotor type capable of giving considerably higher intensities although at the sacrifice of height of column of solution and homogeneity of the centrifugal field. Reducing the mean radius to 36 mm. and the height of sample to 8 mm. sedimentation measurements in fields up to 600,000 g. were made in the autumn of 1933 and up to 900,000 g. in the summer of 1934. The rotors used in these experiments exploded however after a few runs. A further reduction of the mean radius to 32·5 mm. and improvements in the construction have made it possible to do regular measurements in fields up to 750,000 g. The comparison of

water thermostat. It is used for sedimentation equilibrium measurements in solutions of high molecular substances and for sedimentation velocity measurements on heavy particles.

The high-speed machine is driven by oil-turbines and has white-metal bearings with movable, damped pistons. The rotor spins in hydrogen of reduced pressure. It is used for velocity measurements in solutions of high-molecular compounds and for equilibrium measurements on low molecular substances.

A few details concerning the oil-turbine ultracentrifuge might be of interest. The rotor (Fig. 1 and 2R) of chromium-nickel steel is supported by horizontal bearings, B_1 and B_2 (Fig. 2), and kept in rotation by

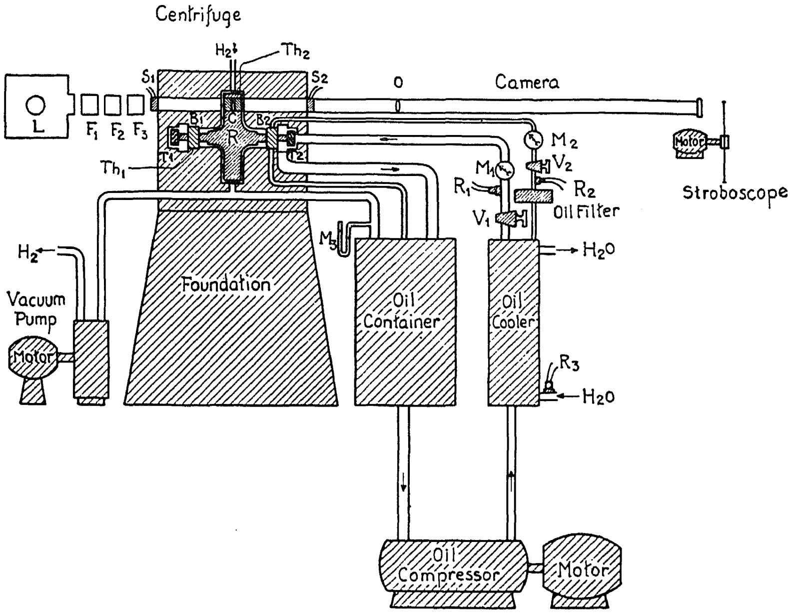


Fig. 2.

Diagrammatic representation of the oil-turbine ultracentrifuge.

means of two small oil-turbines, T_1 and T_2, one on each end of the shaft. Hydrogen is let in at the periphery and constantly pumped off so as to maintain a pressure of about 25 mm. Thermocouples, Th_1 and Th_2, in the bearings and at the inner surface of the heavy steel casing, which surrounds the rotor, serve for temperature control of the centrifuge. A beam of light from a mercury lamp L, filtered through F_1, F_2, F_3, passes the cell C in the rotor on its way to the camera. The exposures are timed by means of the electromagnetic shutters S_1 and S_2. A stroboscope enables the observer to measure the speed of the rotor. The pressure oil which feeds the turbines is produced by a special oil compressor and cooled to a suitable temperature before entering the turbine chambers. The lubricating oil for the bearings passes through an oil filter and is controlled by the valve V_2. By changing the speed of the motor which drives the compressor and by operating the valve V_1 the pressure of the oil entering the turbines may be regulated so as to make possible sedimentation measurements at any desired speed between 5,000 and 140,000 r.p.m. The resistance thermometers R_1, R_2, R_3 and the manometers M_1, M_2, M_3 enable the operator to control temperature and pressure in various parts of the machinery.

A detail section of the centrifuge proper through the axis of rotation (with a previous

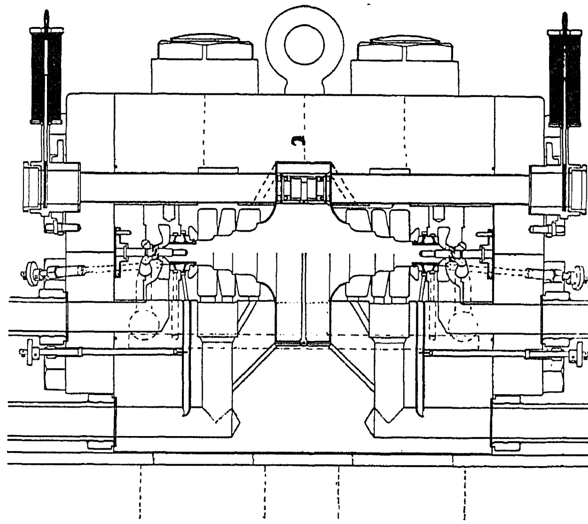


Fig. 3.

Axial section of the oil-turbine ultracentrifuge.

type of rotor) is given in Fig. 3. Fig. 4 shows a picture of it with the upper part of the heavy steel casing lifted, laying bare the rotor and the turbine chambers. The cell with its sector diaphragm is in vertical position upside down. Behind the centrifuge is the lamp house and the light filters. The two halves of the thick steel casing are held together by bolts of chromium-nickel steel firmly anchored in a concrete

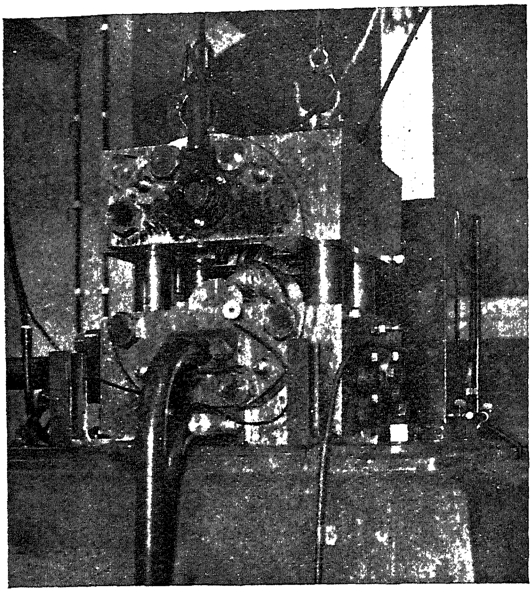


Fig. 4.
The oil-turbine ultracentrifuge with the upper part of the casing lifted.

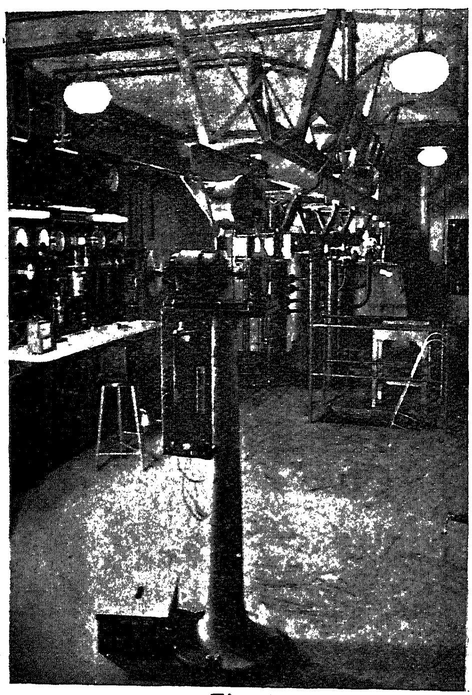


Fig. 5.
Oil-turbine ultracentrifuge installation.

foundation. This arrangement has proved an efficient protection in case of accident (explosion of the rotor caused by overstrain). Fig. 5 gives a total view of the installation showing the stroboscope for measuring the speed, the camera, the centrifuge on its foundation, the oil coolers and, to the left, the switchboard with all the control instruments.

Two kinds of measurements can be done by means of the ultracentrifuge. In the first place, one may centrifuge long enough for a state of equilibrium to be reached between sedimentation and diffusion. Then for each molecular (or particle) species the following formula is valid:

$$M = \frac{2\,RT\,ln\ (c_2/c_1)}{(1-V\rho)\omega^2(x_2{}^2-x_1{}^2)}$$

where M = molecular (or particle) weight, R = gas constant, T = absolute temperature, c = concentration of solute, V = partial specific volume of solute, ρ = density of solvent, x = distance from centre of rotation, ω = angular velocity.

In this way one obtains directly the molecular weight. If several molecular species are present in the solution the molecular weight values calculated for different distances from the centre of rotation show a marked drift. Freedom from drift is a criterion of homogeneity with regard to molecular weight.

In the second place one may use a centrifugal field strong enough to cause the molecules or particles to sediment with measurable velocity. This procedure enables

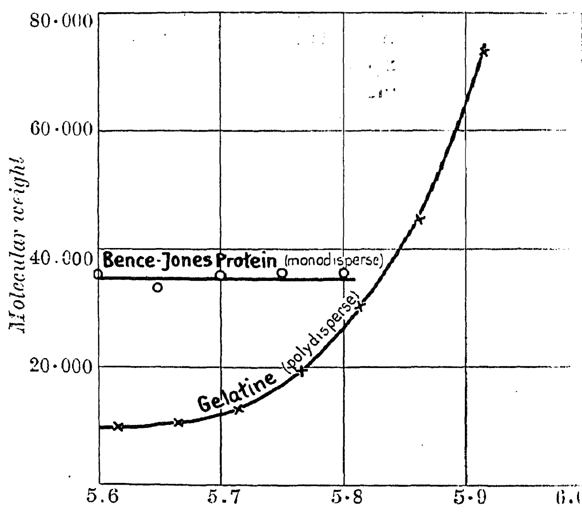


Fig. 6.
Sedimentation equilibrium of Bence-Jones protein (monodisperse) and gelatine (polydisperse).
(B. Sgögren and K. Krishnamurti)

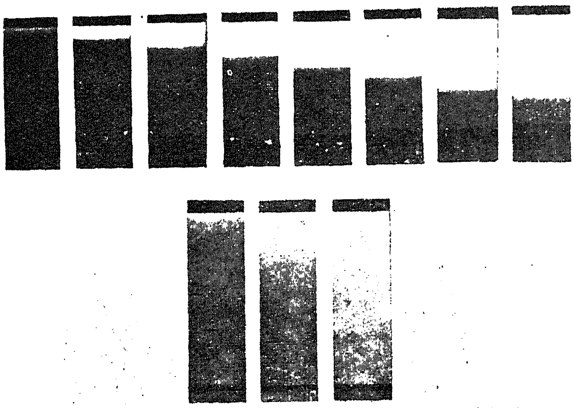


Fig. 7.

Sedimentation of hemocyanin (upper row) and gold colloid (lower row) in a centrifugal field 37,000 times the force of gravity; time between exposures 3 minutes. The former is monodisperse, the latter polydisperse. (E. Chirncaga and H. Rinde)

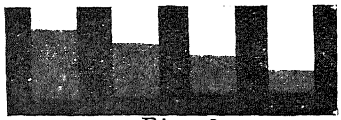


Fig. 8.

Sedimentation of hemoglobin in a centrifugal field 900,000 times the force of gravity; time between exposures 3 minutes. (Inga-Britta Eriksson-Quensel)

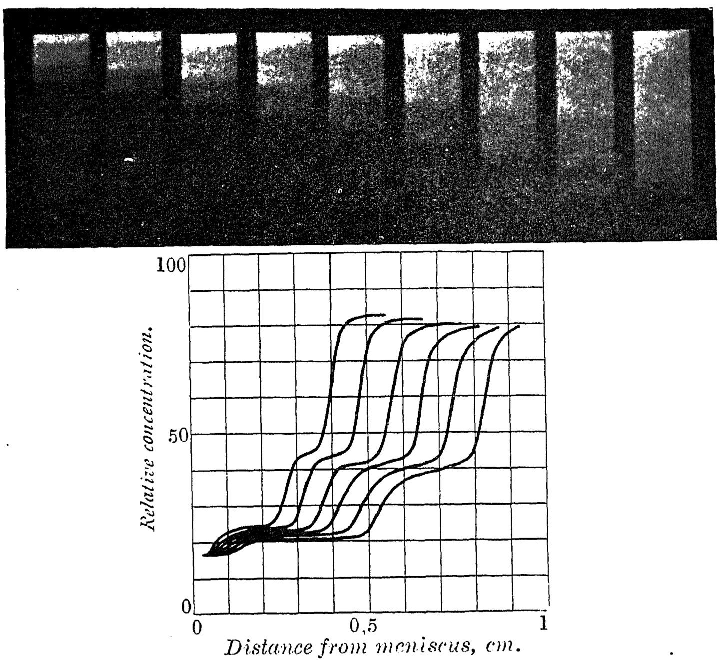


Fig. 9.

Sedimentation analysis of Helix-hemocyanin at the alkaline border of the stability region. Centrifugal field 33,000 g.; time between exposures 5 minutes. (K. O. Pederson)

us to find how many different kinds of molecules are present in the solution. If the sedimentation velocity is referred to unit field and water of 20° C. as solvent, it is called the sedimentation constant. By combining diffusion and sedimentation data the weight of the different molecular species may be calculated according to the formula

$$M = \frac{RTs}{D(1-V\rho)}$$

where s = sedimentation constant, D = diffusion constant.

Sedimentation measurements in the ultracentrifuge may also be used for the determination of the weight-distribution or size-distribution of molecules or particles in a polydisperse mixture. The theory being rather complicated we will not go into it on this occasion.

ii.

The ultracentrifuge has a wide range of

application. With the aid of this tool molecular weight determinations have been done from about 10,000,000 (hemocyanin-variety in the blood of the snail Busycon) down to about 40 (lithium chloride). Quite unique is the possibility which this technique offers of carrying out an analysis of the various molecular species or particle sizes present in a solution. The sedimentation constant is a very characteristic molecular

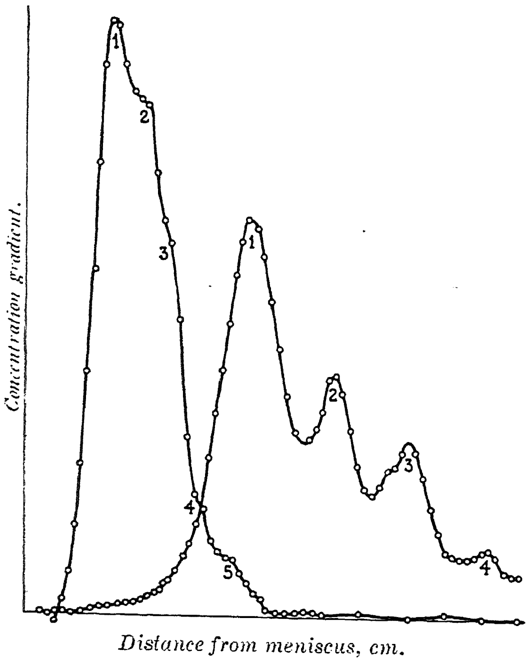


Fig. 10.

Refractometric sedimentation diagram of diluted blood-plasma from a case of myeloma; centrifugal force 260,000 g., time of centrifuging 15 and 60 minutes. (A. S. McFarlane)

property and by means of it, one often finds it possible to follow sensitive aggregation- and dissociation-reactions in biological systems. The combination of sedimentation equilibrium and sedimentation velocity measurements allows of certain conclusions with regard to the shape of the molecules or particles. This is often of importance when investigating high-molecular compounds.

Among the substances studied so far are proteins, polysaccharides, poly-styrols, dye-stuffs and other synthetic organic compounds as well as inorganic colloids and inorganic salts.

Some of the main results of the protein investigations may be mentioned. The native proteins are very homogeneous with regard to molecular weight while artificial colloids as well as proteins extracted from the organisms by rough treatment are poly-disperse. As an example of a homogeneity test by means of sedimentation equilibrium measurements the diagram Fig. 6 gives the values of the molecular weight as measured at different distances from the centre

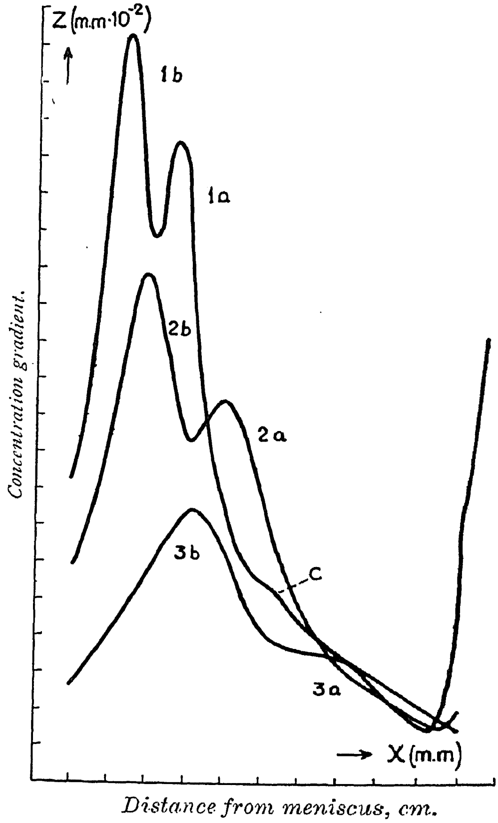


Fig. 11.

Refractometric sedimentation diagram of a solution of starch treated with acid, centrifugal force 145,000 g. (O. Lamm)

of rotation in the case of a homogeneous substance, Bence-Jones protein (B. Sgögren) and an inhomogeneous substance, gelatine (K. Krishnamurti). This is further demonstrated by the sedimentation velocity runs in Fig. 7 which shows in the upper row (E. Chirnoaga) the sedimentation of hemocyanin from the blood of Helix (M = 6,600,000) and in the lower (H. Rinde) the sedimentation of a gold colloid, both of them in a centrifugal field 37,000 g. In the first case the border-line between solution and solvent remains sharp, in the second case it becomes blurred with time because of the different speed with which the gold particles of different sizes are sedimenting. To test the homo-

geneity of a substance of lower molecular weight by a velocity run the centrifugal force has to be increased so as to get sufficient sedimentation before a blurring of the boundary by diffusion takes place. Fig. 8 shows the sedimentation of hemoglobin (M = 69,000) in a centrifugal field 900,000 times the force of gravity (Inga-Britta Eriksson-Quensel). The border-line remains sharp and the protein in question is, accordingly, quite homogeneous.

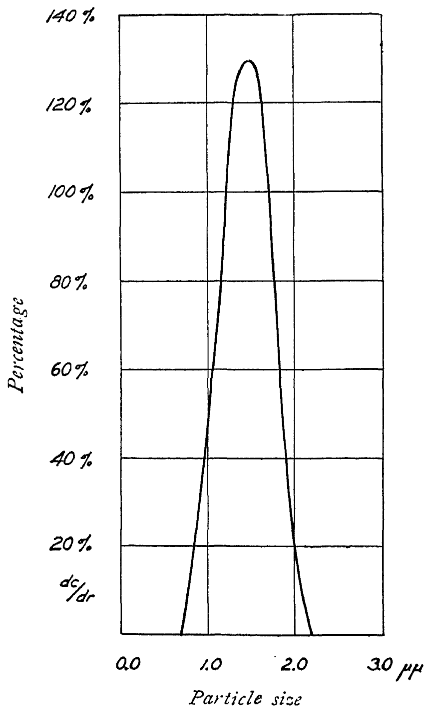


Fig. 12.
Size-distribution in a gold colloid.
(H. Rinde)

The molecular homogeneity of a protein remains unchanged when the pH of the solution is changed within certain limits. At well-defined pH-values changes in the shape or in the weight of the protein molecule take place. Among the hemocyanins a number of reversible dissociation-association reactions have been observed. As an example the behaviour of Helix-hemocyanin at the alkaline stability border may be given. Fig. 9 (K. O. Pedersen) shows the presence of two dissociation products of mass $\frac{1}{2}$ and $\frac{1}{8}$ together with unchanged molecules. A closer study of this phenomenon reveals the fact that the hemocyanin-molecule is at first split into halves and some of these halves into four parts (Inga-Britta Eriksson-Quensel).

In some cases the association state of a protein is dependent on the dilution and on the presence of other proteins. Recent investigations on serum have shown (A. S. McFarlane) that the globulin may appear in molecules of different mass according to the concentration of the albumin present in the serum. Pathological states of the organism bring about characteristic changes in the sedimentation diagram of the serum proteins (Fig. 10), a fact that suggests the use of the ultracentrifuge as a possible instrument for diagnostic purposes.

An ultracentrifugal study of solutions of starch (O. Lamm) has given the following result. Depending on the previous treatment the particle size varies, but always in a continuous way. No distinct molecular species were found. Preparations treated with acid show two maxima corresponding to amylose and amylopectin (Fig. 11). A detailed investigation of the solutions of poly-styrols in various organic solvents has been carried out (R. Signer). The molecules were found to be very elongated and free movement was observed only in very dilute solutions. The viscosity increases with molecular weight. Gold colloids were among the first objects of ultracentrifugal investigations. Fig. 12 shows the size-distribution curve of a very fine-grained gold sol (H. Rinde).

iii.

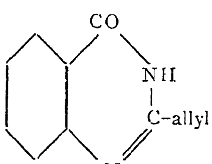
The utilisation of the ultracentrifuge for the study of high molecular compounds is only at its beginning. As research goes on new problems present themselves for treatment with this new tool. So far the main interest of applications has been in the field of biology and medicine because of the various kinds of new information which the ultracentrifuge has made available with regard to the behaviour of the proteins—those substances of paramount importance to all living beings. But there are also the vast fields of the carbohydrates, the hydrocarbons and the synthetic organic high-molecular compounds. A number of important chemical industries are handling materials belonging to one or the other of these classes of substances. The research laboratories connected with such industries are beginning to realise that the ultracentrifuge may be able to render services of great value in elucidating the properties of the molecules and particles which are the building-stones of cellulose, artificial silk, varnishes, rubber, dyes and many other products,

Vasicine.

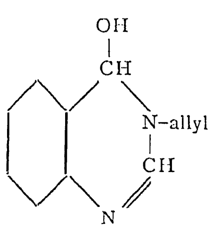
By K. S. Narang and J. N. Ray.
(University Chemical Laboratories, The University of the Panjab, Lahore.)

VASICINE, $C_{11}H_{12}ON_2$, an alkaloid, was isolated from the leaves of *Adhatoda Vasica*, Ness by Sen and Ghosh.[1] It was found to be a monacid base and further studies by Ghosh[2] revealed the presence of a quinazoline ring. With phosphorous penta-chloride, it was converted into chloro-desoxy vasicine indicating that a hydroxy group replaceable by chlorine exists in the molecule. With alkaline permanganate it gave a substance believed to be 4-oxyquinazoline but direct proof of its formation was furnished by Ghosh, Krishna, Narang and Ray.[3] Ghosh[2] was of the opinion that vasicine was 2-propyl 4-oxyquinazoline, a substance which was later on synthesised by De and Ray[4] and proved to be not identical with vasicine. Ghosh, Krishna, Narang and Ray[3] found evidence that vasicine is converted into an isomeric substance by traces of alkali and gave a solid acetyl derivative. But Narang and Ray[5] were of opinion that the isomeric base may be impure vasicine.

In 1934, Späth and Nikawitz[6] were supplied by the firm of E. Merck, a base isolated from the mother liquors of *peganam harmala*. This base melted at a slightly higher temperature because the m.p. was determined *in vacuo*. Its formula was $C_{11}H_{12}ON_2$ but it gave a liquid acetyl derivative and hence the question of its identity with vasicine was left open by these authors. Oxidation with permanganate furnished 4-oxy-quinazoline 3-acetic acid and hence the formula II was advanced by Späth and Nikawitz as



I



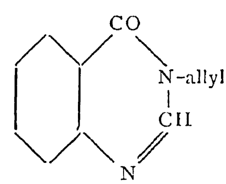
II

against (I) advanced sometime ago for vasicine by Ghosh, Krishna, Narang and Ray.[3] The solubility of vasicine in acetone also differed from the solubility of peganine in the same solvent. Hanford, Liang and Adams[10] showed the solubility of vasicine in acetone to be small as observed by Ghosh, Krishna, Narang and Ray[3] and the greater solubility of peganine must be due to associated impurities.

Narang and Ray[5] criticised the Späth-Nikawitz formula on various grounds and expressed the opinion that vasicine may not after all be identical with peganine because the acetyl derivative has been found by Späth and Nikawitz[6] to be an oil as against the solid dehydro acetyl derivative of Ghosh, Krishna, Narang and Ray.[3]

Späth and Kuffner[7] however definitely established the identity of vasicine and peganine. Reynolds and Robinson[8] suggested that in view of identity of vasicine and peganine, the latter name is redundant. These authors[8] conclusively proved the Späth-Nikawitz formula to be incorrect by synthesising a substance of the structure II by an unambiguous method. Narang and Ray[9] advanced additional evidence against formula II proposed by Späth and Nikawitz.

Narang and Ray[5] synthesised the compound III and proved that its reduction product with sodium and amyl alcohol was not identical with the similar reduction product of vasicine and hence the structure II advocated by Späth and Nikawitz was untenable. In this connection it must be stated that Späth obtained a base $C_{11}H_{16}N_2$ by the reduction of vasicine. It is impossible to get a substance of that formula from vasicine.



III

Narang and Ray[9] then proposed two formulæ—one a cyclic system of three rings and another, an open chain—for vasicine. If the open chain one was the correct representation of vasicine, then in oxidation and other

1 *J. Indian Chem. Soc.*, 1925, **1**, 315.
2 *J. Indian Chem. Soc.*, 1927, **4**, 1.
3 *J. Chem. Soc.*, 1932, 2740.
J. Indian Chem. Soc., 1927, **4**, 541.
Curr. Sci., 1934, **2**, 388.
Ber., 1934, **67**, 45.
7 *Ber.*, 1934, **67**, 868.
8 *Nature*, 1934, **134**, 142.
9 *Chem. and Industry*, 1934, **53**, 698.
10 *J. Amer. Chem. Soc.*, 1934, **56**, 2780.

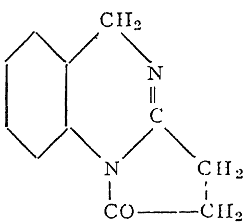
reactions it passed through an intermediate tricyclic stage. They further pointed out that desoxy-vasicine was not identical with 3-allyl 3 : 4 dihydroquinazoline as would be the case if formula II of Späth and Nikawitz was the correct structure of vasicine. Hanford, Liang and Adams,[10] besides supporting Narang and Ray,[9] advanced the additional argument that 3-allyl 4-keto 3 : 4 dihydroquinazoline can be catalytically reduced, whilst vasicine is unaffected. They advanced a cyclic formula for vasicine which is much nearer the truth than the set of random suggestions of Späth and Nikawitz.[6] Moreover the position of the hydroxyl was taken to be in β-position in the third ring whilst actually it is in α-position. It must be stated that Späth and Nikawitz only suggested in their paper all possible variations in which $C_{11}H_{12}ON_2$ can be arranged as a quinazoline and it is not fair to attribute to them the formula that later on was proved to be correct.

Narang and Ray[11] prepared IV and V and found that the electrolytic reduction product of IV was not identical with the similar product from vasicine but the reduction product of V was identical with the reduction product of vasicine. Hence vasicine has a linear cyclic formula. Späth, Kuffner and Platzer[12] synthesised desoxy vasicine from *o*-nitro-benzylamino butyric acid which, on reduction and treatment with phosphoryl chloride, passed into a substance which, on reduction with sodium and amyl alcohol, furnished a product identical with the reduction product of desoxy vasicine. This product is identical with the reduction product of V. Neither the work of Späth, Kuffner and Platzer[12] nor that of Narang and Ray[11] furnishes any proof of the position of the hydroxy group. But Morris, Hanford and Adams[13] furnish an acceptable evidence of the position of the alcoholic hydroxyl group.

Finally *o*-nitrobenzyl chloride on condensation with α-hydroxy-γ-aminobutyrate furnished a product which was cyclised, after reduction to a substance identical with vasicine, by Späth, Kuffner and Platzer[14] and hence vasicine becomes VI. It will be seen that the hydroxyl group is attached to the α-position and is not in the β-position, where it figures in the various formulæ proposed by Späth and Nikawitz.[6]

Späth, Kuffner and Platzer[15] now find that vasicine gives a solid acetyl (dehydro) as stated by Ghosh, Krishna, Narang and Ray.[3] Narang and Ray[5] based their view of non-identity of vasicine and peganine on Späth's reporting the acetyl derivative to be a liquid.

Späth, Kuffner and Platzer[16] have resolved vasicine into optical enantromorphs but since natural vasicine is a *dl* compound, this paper has no bearing on the constitution of vasicine. But Ghosh, Krishna, Narang and Ray have already stated that vasicine is resolvable, a fact which Späth, Kuffner and Platzer have acknowledged.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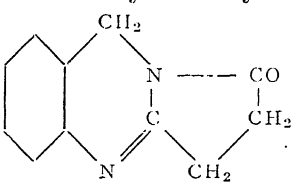
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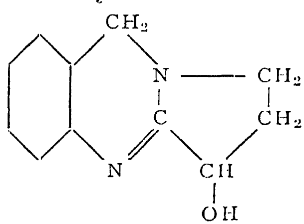
VI

[11] *Curr. Sci.*, 1935, **3**, 352.
[12] *Ber.*, 1935, **68**, 497.
[13] *J. Amer. Chem. Soc.*, 1935, **57**, 921 and 951.
[14] *Ber.*, 1935, **68** (**B**), 702.
[15] *Ber.*, 1935, **68** (**B**), 935.
[16] *Ber.*, 1935, **68** (**B**), 1386.

A Ram Sarcophagus from Cuddapah.

By M. D. Raghavan, M.A., *Government Museum, Madras.*

THE terra-cotta sarcophagus illustrated was unearthed at Sankavaram, a small village about two miles north of the town of Porumamilla, in February 1935, in the Badvel Taluk of Cuddapah District, in the course of digging for the foundations of a new church. The discovery was brought to the notice of the authorities of the Madras Museum by the Bishop of Dornakal. The sarcophagus and the associated pottery were carefully preserved by the parson, Rev. Christudary, at the S.P.G. Parsonage at the adjoining village of Markapuram, until I took charge of them, and removed them to the Museum in May last. The objects were exhibited before a meeting of the Archæological Society of South India at Madras in June, and evoked considerable interest.

The human character of the interment which the sarcophagus contained is not open to doubt as is evident from the skeletal remains. There is no charring of the bones which are so much decayed that they have turned completely white.

The sarcophagus is of unique interest in that it is in the shape of a ram. The ram's head is clearly modelled, the curling horns being emphasised, and the ears omitted. The only other funerary vessel in animal

'nown from South India is a small- 'om the left bank of the Tunga- er, with a rounded body, and ped legs, which suggested to e an elephantoid form.[1] Its head part was, however, not found and in the absence of this part the identification of an elephantoid form cannot be definite.

The trunk of the ram is so modelled that the lower part of it, supported by the legs, forms the receptacle for the bones, and the upper part forms a lid. This upper part is modelled in two pieces, the section in front ending in a well-arched neck, at the apex of which is a wide aperture. About half way from the top a hole is placed symmetrically on either side of this section. The portion of the lid behind is well rounded, and is so modelled as to simulate the hind part of an animal, which only lacks the tail to complete the picture.

Elaborate decoration with impressed rope-work design is a feature of the object, the decoration extending all around the borders, and running longitudinally along the central line of the lid from the neck to the hind quarters. The character of this decoration is suggestive of the trappings of an animal caparisoned for riding.

For the proper understanding of the probable significance of the ram form, we have to take note of the vast complex of ideas associated in the mind of primitive man with the animal kingdom. The domestication of animals fostered a feeling of kinship, and greatly influenced primitive man's attitude towards death. Certain animals came to be regarded as embodiments of the souls of the dead, and the ram often served as one such soul-animal. The sheep was the object of special rites with all pastoral peoples; it entered so much into the life of all early peoples that it was the chosen animal to bear all the sins and evils of mankind as the goat was among the Jews.

With the idea of the ram as a soul-animal, which has the soul of the deceased in its keeping, is possibly linked the idea of its acting as a convoy in transporting the soul to the spirit world, an idea which is suggested by the decorative trappings of the ram as if caparisoned for riding.

Of obvious significance in this connection is the position assigned to the ram in the hierarchy of the gods of early Indian faith.

[1] Bruce Foote, "Indian Pre-historic and Proto historic Antiquities—Notes on their Ages and Distribution," 185-86.

A deity invoked as early as the Rig Vedic times for obtaining a son was Naigamēsha. In the medical treatises, Naigamēsha is, however, a ram-faced demon causing children's diseases. Offerings to the ram-faced god are among the remedies prescribed for such diseases. This association of two opposite ideas—that of a deity dangerous to children, and of a deity helpful in the procreation of children, is interesting.[2] The enclosing of the bones of the deceased within a ram-faced sarcophagus would seem to suggest a request to Naigamēsha to ensure that the deceased might through his influence be born back on earth.

The clay sarcophagus lay at a depth of about 6 feet below ground level. Perhaps the most conspicuous feature of the land is the abundance of rounded pebbles and boulders strewn about the place, indicative of considerable surface denudation. Situated in the slope of the valley formed by the spurs of the Eastern Ghats, the place has apparently witnessed considerable changes in climate. The geology of the country is a matter for further investigation.

The associated finds are two pieces of iron objects—a spear head and a fragment of a knife or sickle—both found inside the sarcophagus highly corroded; and an interesting series of pottery, a squat type of vessel with shield-shaped back, and shallow all-black pans predominating. The pans are highly polished and some bear spiral marking inside.

The ram sarcophagus is also interesting for the evidence it gives of the early domestication of sheep in this part of South India, where sheep farming is still a most flourishing industry.

[2] Prof. M. Winternitz in *J.R.A.S.*, 1895, pp. 145-155; Bühler in *Epigraphia Indica*, **11**, pp. 314-18.

Diwan Bahadur Sir T. Vijayaraghavacharya.

THE retirement of Diwan Bahadur Sir T. Vijayaraghavacharya on October 25th after a short period of leave, marked the completion of a long and distinguished record of Government service. The Diwan Bahadur was born at Karur in 1875 and entered the Madras Civil Service in 1898 so that he has 37 years of service to his credit. He rapidly made his mark as a district officer and the intimate knowledge of village life then gained has stood him in good stead. His first administrative post was with the Madras City Corporation from 1912 to 1917. After a period as Secretary to the Board of Revenue, which gave him a further insight into revenue administration, he was Diwan of the Cochin State in 1919 till 1922. The Diwan Bahadur first became known to most people in other parts of India as Commissioner for India at the British Empire Exhibition, Wembley—a task which occupied him from 1922 to 1925 and where his great organising ability had full scope. His distinguished services to India and the Empire were appropriately recognised in 1926 when the Knighthood of the Most Excellent Order of the British Empire was conferred upon him by His Majesty. On return to India, he became Director of Industries, Madras, for a short period but was very soon appointed as Member of the Public Service Commission when that body was first constituted. When Sir Vijaya became the first Vice-Chairman of the Imperial Council of Agricultural Research in 1929, he possessed in full measure the qualifications laid down as essential for the Council's principal administrative officer by the Royal Commission on Agriculture. An agriculturist and landowner by birth and tradition with long and varied administrative experience, he was able to appreciate all points of view and displayed great skill in the conduct of debates which were frequently highly technical in character. As a Chairman, his impartiality and never-failing good humour were coupled with the gift of accelerating business. Outside the formal meetings, his relations with all members of the Research Council and his staff were most happy. Not only did he promote co-operation within the Council but he made its aims, objects and work well known throughout India and secured for it a wide measure of unofficial support. During the period of retrenchment and financial stringency, which overtook the Council early in its career, his sustained optimism and constant advocacy of the fundamental importance of agricultural research to the well-being of the Indian nation were invaluable. That the Imperial Council of Agricultural Research has been able to go as far as it has in the direction of fulfilling the intentions of its distinguished

founders is due in no small measure to the personality of its first Vice-Chairman. He did much to bring the Research Council into touch with the Indian Universities. He was an active member of the Indian Science Congress, over the Agricultural Section of which he presided in 1930, and he became a foundation Fellow of the National Institute of Sciences of India on the formation of that body in January 1935. Scientific workers in all subjects found in him a sympathetic and understanding listener. In later years Sir Vijaya was a great traveller. His duties as Commissioner for the Wembley Exhibition took him all over India as well as to England. In 1926 he opened the Canadian National Exhibition at Toronto and gained many friends in that Dominion. In 1930 he led the Indian Delegation at the General Assembly of the International Institute of Agriculture and visited Europe again early in 1932. In the following year he gave evidence before the Joint Parliamentary Committee on the Government of India Bill and he made another flying visit to England and the Continent in 1934. In India he toured freely on the Council's business. The Diwan Bahadur is now enjoying a well-earned holiday in England but has by no means abandoned his interest in Indian agricultural affairs. Fortunately neither the Imperial Council of Agricultural Research, nor the Indian Central Cotton Committee, of which he was Chairman for six years, will lose the benefit of his experience for the Government of India have appointed him, by name, as a member of both these organisations. His many friends in Simla, Delhi and South India can wish him a happy period of retirement in the full knowledge that his active and versatile mind will still be fully occupied for the benefit of his country.

B. C. B.

SANDALWOOD—Hawaii's Most Valuable Tree.

SANDALWOOD, theme of a thousand romances and poems of early commerce, is being groomed for a comeback in the forests of Hawaii. It once existed there in great quantities, but over-exploitation 125 years ago by an alliance of traders and native potentates almost wiped it out.

The forests were devastated at that time because of the high prices that could be secured in China for this sweet-scented wood. They promise to be re-established because that price still maintains.

C. S. Judd, territorial forester, some years ago secured from Mysore (India), seeds of what is held to be the most valuable species of sandalwood. He planted these seeds on a ridge in the suburbs of Honolulu and they grew abundantly. To-day there are some 1,500 three-year-old trees on this ridge. They are bearing all the seed that is needed for nursery use. Apart from these, an old sandalwood tree is occasionally found in some remote mountain canyon.

In the pots at the nurseries in Hawaii ironwood seeds are planted with the sandalwood. In its native state the sandalwood always grows among other trees and helps itself to aid from their roots, as a partial parasite. On the ridge that overlooks Honolulu where 1,500 young trees are growing vigorously they stand among lantana bushes, members of the verbena family.

Sandalwood trees grow rather rapidly. They are of some value at the age of 25 years. It is the heart of the tree, however, that is most precious, and heart-wood is not likely to develop greatly until the tree is 40 or 50 years old. Since the present plantings are chiefly in territorial forests, however, the profits do not need to be immediate to make the enterprise sound.

—*Science*, 1935, **82**, No. 2129, (Supplement, p. 7).

Letters to the Editor.

CONTENTS.

The Raman Spectrum of Crystalline Selenious Acid.

PRINGSHEIM AND YOST[1] studied the Raman effect in an aqueous solution of selenious acid (H_2SeO_3) and recorded two broad and fairly intense lines of frequency shifts 695 and 885 cm^{-1}. I have recently investigated this substance in the form of transparent crystals and obtained a very intense spectrum at an exposure of about four hours which consists of a large number of sharp lines. The photograph of the spectrum is reproduced in Fig. 1. The frequency numbers of these lines in cm.$^{-1}$ are 940 (1), 909 (2), $\overline{888}$ (10), 862 (0), 706 (3), $\overline{597}$ (8), 524 (3), 364 (0), $\overline{299}$ (2), $\overline{287}$ (3), $\overline{254}$ (6) and $\overline{199}$ (3). The numbers within the brackets indicate the relative intensities of these lines and a dash above some of them shows that their anti-stokes are also present. These lines have been obtained with 4046 and 4358 radiations of the mercury arc with equal intensity.

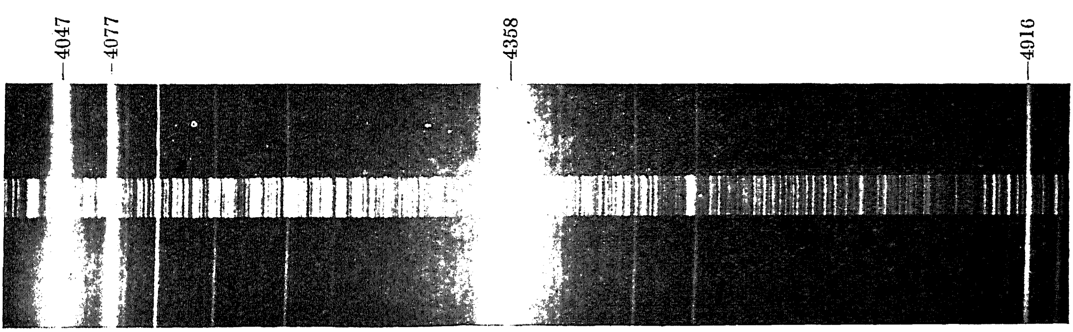

Fig. 1.

The spectrum of the solid is thus markedly different from that of the aqueous solution of this acid and resembles, in its general features, the anomalous behaviour observed by me in the iodic acid.[2] The detailed investigation of this acid as well as the selenic

acid as solid and solutions of different concentrations and their salts is under progress and a full report of the results and their significance in relation to their structure and electrolytic dissociation will appear in the *Proceedings of the Indian Academy of Sciences*.

C. S. VENKATESWARAN.

Department of Physics,
Indian Institute of Science,
Bangalore.
October 31, 1935.

[1] Pringsheim and Yost, *Z. Physik*, 1929, **58**, 1.

[2] Venkateswaran, C. S., *Proc. Indian Acad. Sci.*, 1935, **2A**, 119.

Determination of the Time of Setting of Gels.

SEVERAL methods have been employed to determine the time required for the setting of a silicic acid gel. Fleming[1] determined it by the criterion that the gel does not flow out of the test tube when it is inverted. Fells and Firth[2] measured it by the maximum pressure required to blow a bubble of air, mercury or chloroform through the gel-forming mixture. Prasad and Hattiangadi[3] noted the intensity of light transmitted through a gel-forming mixture by means of a thermopile connected to a sensitive galvanometer and read the time of setting from the time-deflection curve. Similar methods have been employed by Mardles[4] and by Aritsz.[5] Hurd and Letteron[6] considered the gel to have set when a small glass rod placed at an angle of 15°–20° in the gel-forming mixture remained in position.

Fleming's method has been compared with the optical method by Prasad and Hattiangadi[7] who showed that the time of setting obtained by the former method is less than that obtained by the latter. The results obtained by optical method have now been compared with those obtained by the Bubble and the Rod methods, respectively. It may be mentioned that mechanical devices were employed for the determination of the time of setting by the latter methods in order to disturb the gel-forming mixtures as little as possible.

The gels were prepared by mixing solutions of sodium silicate and hydrochloric acid. The results given in the following Table show that the Bubble method gives the least and the optical method the highest value for the time of setting.

TABLE I.

N	C = 9·8 per cent.			C = 12·1 per cent.		
	I	II	III	I	II	III
0·5	87′-30″	78′-0″	101	137	120	152
0·6	35′-0″	24′-0″	48	39	27	65
0·7	2′-50″	1′-40″	10	3′-15″	2	15

N and C are, respectively, the normality of HCl and the silica content of the gel-forming mixture and I, II and III, the time of setting in minutes by the Rod, Bubble and Optical methods, respectively.

It will be seen that Fleming's, the Rod and the Bubble methods depend upon the attainment of a certain viscosity value, different from each other, by the gel-forming mixture. The observed differences in the time of setting by the Bubble and the Rod methods are due to the fact that greater viscosity is required to prevent a glass rod from falling from a certain position than that needed to prevent the blowing of bubbles of a gas or a liquid, which are very elastic, through the gel-forming mixture.

It appears, therefore, necessary to define the term "time of setting of a gel" before applying any method for measuring the same. It is now fairly well established that the process of gelation includes (i) the formation of the colloidal solution of the gelling substance, (ii) its coagulation, hydration and agglomeration, and (iii) the formation of the specific structures; other structural changes which eventually take place such as synersis, etc., can be neglected. A gel should, therefore, be considered as set only when all the three processes mentioned above are complete and not when the gelling substance has gone through a certain part of the increased hydration and the increased viscosity of the second process. In such a case a method such as the optical method which takes into account all the changes which the gel-forming mixture undergoes during gelation, should give a reliable value of the time of setting of the gel. The application of such a method will, of course, be limited to those gel-forming mixtures which are clear before gelation starts and continuously change in transparency till all the

changes involved in the setting of a gel are complete.

MATA PRASAD.
M. U. PARMAR.

Chemistry Laboratories,
Royal Institute of Science,
Bombay,
October 29, 1935.

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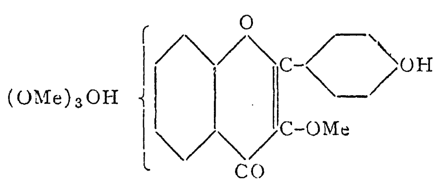
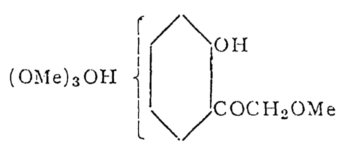
[1] Fleming, *Zeit. Phys.*, 1902. **41,** 427.
[2] Fells and Ferth, *Trans. Farad. Soc.*, 1927, **23,** 25.
[3] Prasad and Hattiangadi *J. Indian Chem. Soc.*, 1926, **6,** 659.
[4] Mardles, *Trans. Farad Soc.*, 1923, **18,** 318.
[5] Aritsz, *Kolloid Chem. Beih.*, 1915, **7,** 14.
[6] Hurd and Letteron, *J. Phys. Chem.*, 1932.
[7] Prasad and Hattiangadi, *loc. cit.*

The Constitution of Calycopterin.

THE anthelminthic constituent, *calycopterin*, of the leaves of *Calycopteris floribunda*, Lamk., has been shown[1] to be a dihydroxy-tetramethoxyflavone and to be identical with the yellow colouring matter isolated by Karrer[2] as a bye-product in the preparation of digitoxin from the leaves of a Spanish *Digitalis.*[3] On fusion with alkali calycopterin gave *p*-hydroxybenzoic acid and the stability of an alkaline solution of the substance to oxidation by atmospheric oxygen pointed to a methoxyl in the 3-position. Calycopterin was represented as (I); with the limited amount of material available the identification of the water-soluble phenol obtained in the course of the degradation with alkali was not practicable; isolation of the phenol in quantity and the orientation of the two hydroxyls and three methoxyls would in any case be extremely difficult in the case of a pentahydroxybenzene derivative. Repeating the alkaline hydrolysis we have now prepared the ketone (II), the colour reactions of which, however, failed to give a definite indication of the position of the hydroxyl in the fused benzene ring of the flavone.

In a recent communication[4] to the *Journal of the Chemical Society* we have reported the demethylation of 5-methoxyflavones to 5-hydroxyflavones by means of aluminium chloride; under prescribed conditions the methoxyl in the 5-position is preferentially attacked and the method may be utilised for the synthesis of partially-methylated polyhydroxyflavones such as tectochrysin (III) and genkwanin (IV). The synthesis of the latter on these lines has just been completed and will be reported elsewhere; the oxidation of the chalkone (V) with selenium dioxide[5] gave the flavone (VI), which was successively debenzylated and demethylated to genkwanin (IV). In the course of this work it was apparent that the action of aluminium chloride on a methoxyflavone might be fruitful as a diagnostic test for the presence of a methoxyl in the 5-position; its application to the specific instance of calycopterin has revealed the position of the


(I)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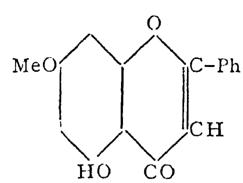
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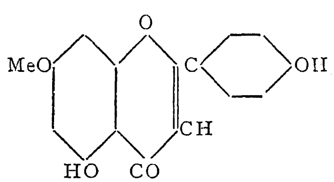
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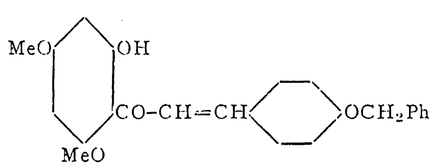
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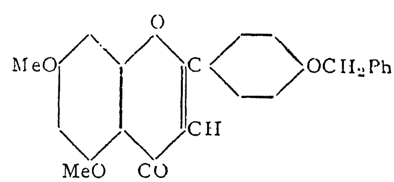
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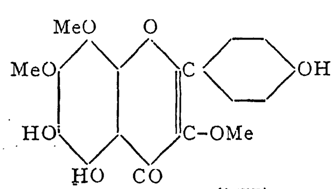
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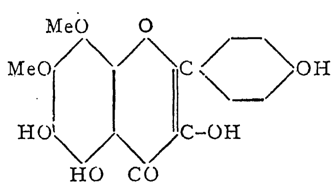
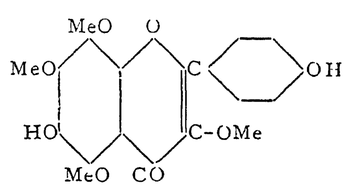

(VIII)


(IX)

hydroxyl in the fused benzene ring. The treatment of calycopterin with aluminium chloride has resulted in a new flavone, which exhibits the usual properties of a catechol derivative, *e.g.*, the characteristic red-brown colouration with ammonium molybdate and acetic acid,[6] and must therefore be 5 : 6 : 4′-trihydroxy-3 : 7 : 8-trimethoxyflavone (VII) or 3 : 5 : 6 : 4′-tetrahydroxy-7 : 8-dimethoxyflavone (VIII); the second alternative needs to be considered since we have noticed that a 3-methoxyl is also susceptible to demethylation by aluminium chloride. The second hydroxyl in calycopterin being in the 6-position, calycopterin may now be formulated as 6 : 4′-dihydroxy-3 : 5 : 7 : 8-tetramethoxyflavone (IX).

H. S. MAHAL.
K. VENKATARAMAN.
Royal Institute of Science, Bombay,
Department of Chemical Technology,
The University, Bombay,
October 19, 1935.

[1] Ratnagiriswaran, Sehra and Venkataraman, *Biochem. J.*, 1934, **28**, 1964.
[2] Karrer, *Helv. Chim. Acta*, 1934, **17**, 1560.
[3] Karrer and Venkataraman, *Nature*, 1935, **135**, 878.
[4] Compare also Bharadwaj and Venkataraman, *Curr. Sci.*, 1933, **2**, 50.
[5] Mahal, Rai and Venkataraman, *J. Chem. Soc.*, 1935, p. 866.
[6] Quastel, *Analyst*, 1931, **56**, 311.

Condensation of ω-Bromoacetophenone with 1-*o*- Aminophenyl-3-Phenylthiocarbamide.

THE condensation of ω-bromoacetophenone with 1-*o*-aminophenyl-3-phenylthiocarbamide yielded a compound (m.p. 230° decomp.; empirical formula $C_{15}H_{13}ON_2SBr$) to which a heptathiodiazine structure was assigned by me.[1] Pathak[2] has obtained, by carrying out the same condensation, a compound (m.p. 223° decomp.) possessing the same empirical formula and finds that it is the hydrobromide of a weak heterocyclic base. These two compounds have been regarded by him as identical.

That the compound (m.p. 230° decomp.) isolated by me is not the hydrobromide of a heterocyclic base but possesses the heptathiodiazine structure is definitely proved by the fact that it is, as already mentioned in my original paper, acidic in nature being soluble in cold dilute alkali and precipitated by acids. This property, *viz.*, that the compound is unaffected by sodium bicarbonate solution and is precipitated *unchanged* by acid from its solution in alkali, has been again established and dispels any idea of the compound being a hydrobromide. The compound melts with decomposition to form a dark brown viscous liquid which emits smell of ω-bromoacetophenone.

In view of the properties of my compound as mentioned in my original paper, it is really surprising how Pathak could regard the two compounds as identical, and his conclusion seems not to be well founded. From Pathak's observations, it seems very probable that his compound is entirely different from mine and slight difference in experimental conditions employed by him may account for the formation of a different compound.

My compound (m.p. 230° decomp.) can be prepared as follows: An intimate mixture of the reactants (equimolecular proportions) is mixed, at ordinary temperature, with glacial acetic acid and shaken, when a clear solution is obtained accompanied by rise in temperature. In about an hour a solid is precipitated which after precipitation from an alkaline solution by acid is crystallised twice from glacial acetic acid in colourless needles.

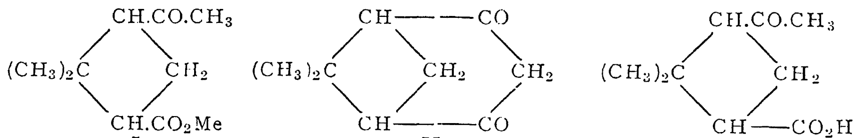
Pathak's further observation by way of comparing the chemical characteristics of both the compounds seems to be desirable.

TEJENDRA NATH GHOSH.
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
September 18, 1935.

[1] T. N. Ghosh *J. Indian Chem. Soc.*, 1931, **8**, 71.
[2] Pathak, *J. Indian Chem. Soc.*, 1935, **12**, 463.

Synthesis of "Ketonopinone" (4 : 6-Diketonopinane).

THE synthesis of pinononic acid (III) and its methyl ester (I) starting from *cis*norpinic anhydride has been reported by us.[1] The conversion of (I) into ketonopinone (II) has now been effected by means of sodium in toluene or sodium methoxide in alcohol solution. Ketonopinone (II), m.p. 104°, purified through its copper derivative (sint 238°) gives a violet coloration with $FeCl_3$, dissolves in sodium bicarbonate, decolourises alkaline permanganate and absorbs bromine in chloroform solution. The constitution was confirmed by hydrolysing it with baryta to pinononic acid (III). Reduction of this diketone to nopinone and nopinane is in progress.



I II III

It can now be observed that this constitutes a *total* synthesis of a bicyclic compound in the pinane group; Ruzicka's synthesis of pinocamphone, α- and δ-pinenes[2] involved the use of pinonic acid yet unsynthesised. Work on the synthesis of pinonic acid starting from norpinic acid is in progress.

Full details will shortly be published elsewhere.

P. C. GUHA.
K. GANAPATHI.

Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
November 2, 1935.

[1] *Curr. Sci.*, 1935, **3**, 484.
[2] *Helv. Chim. Acta.*, 1920, **3**, 756; 1924, **7**, 489.

A Manometric Device for Gas Analysis.

FOR the quantitative measurement of the respiratory gaseous exchange in plants Haldane's gas-analysis apparatus is generally used. The apparatus is undoubtedly highly accurate but requires considerable skill before it can be used with discrimination. The construction of the apparatus is complex and an accidental breakage in the glass parts is not easily repaired. In the course of some physiological investigations connected with the Fruit-Preserving and Fruit-Canning industries where a high degree of accuracy is by no means essential, the need was felt for simple and effective means of gas analysis. With this object in view a simple apparatus for gas analysis was constructed in this laboratory and has been in use for some time with satisfactory results. Over the existing forms of the gas-analysis apparatus, it possesses the following advantages: (1) Sampling the gaseous mixture is exceedingly easy. (2) The use of phosphorus[1] as an absorbent for oxygen instead of potassium pyrogallate obviates the necessity of keeping the gaseous sample in a state of continuous agitation which is often very tiring.

The principle of the apparatus (Fig. 1) consists, in brief, in measuring the pressures exercised by the various constituents of a gaseous mixture. As the partial pressure of a component is proportional to its concentration in the gaseous sample and the sum of the various partial pressures is equal to the total pressure exerted by the gas sample, the percentage content of the component, say x, is easily computed :—

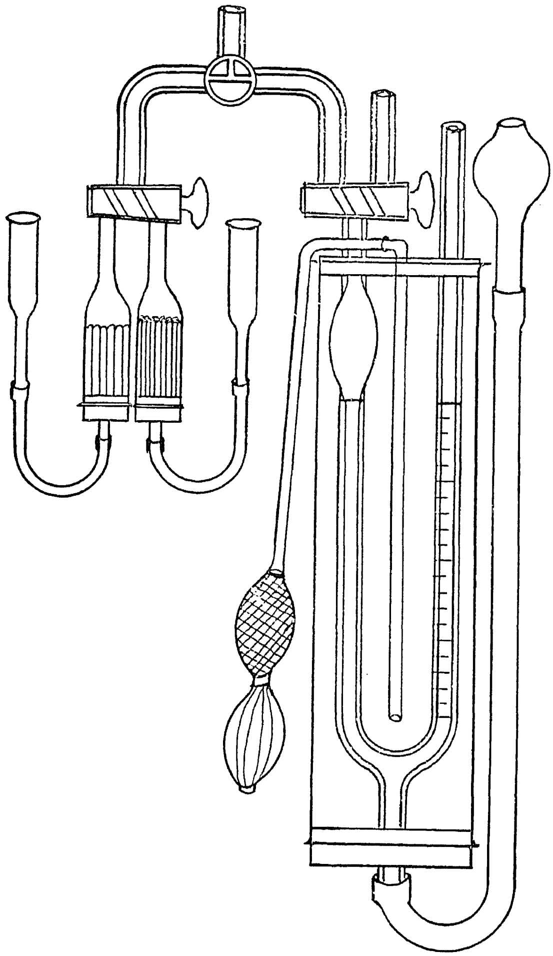


Fig. 1.
A manometric device for gas analysis.

$$x = \frac{h \times 100}{H_0}$$

where h=the partial pressure of the component under consideration, and H_0 = atmospheric pressure in mm. Hg.

A detailed description of the apparatus will appear elsewhere.

B. N. SINGH.
P. B. MATHUR.

Laboratories for Plant Physiology,
Institute of Agricultural Research,
Benares Hindu University.
July 23, 1935.

[1] Carpenter, *Carnegie Inst. Wash. Pub.*, 1915, **216**, 76.

Uric Acid Crystals in the Blood Plasma of a Fowl suffering from Pyo-nephrosis consequent on Vitamin A Deficiency.

AN investigation is being undertaken on the growth of embryonic tissues in vitro on plasma taken from vitamin A deficient fowls and rats. In the course of the investigation blood was taken from a fowl which had been fed for 12 weeks on the following diet :—

Milled Rice	..	65 parts.
Ground Whole Rice	..	15 ,,
Casein	..	12 ,,
NaCl	..	1 ,,
$CaCO_3$	..	1 ,,
$Ca_2H_2(PO_4)_2$	..	1 ,,
Dried Yeast	..	5 ,,

Under light ether anæsthesia blood was drawn from the carotid artery. Directly after centrifuging the plasma appeared quite clear. In spite, however, of the fact that the blood was drawn through an ice-cold paraffined canula into a paraffined centrifuge tube and kept in ice packing until centrifuging, clotting occurred within a few minutes of centrifuging. The plasma of a normal fowl, collected and treated in this manner, can be kept in cold storage for months without clotting. In the present instance it was observed that the serum exudating from the clot was turbid and under the microscope it was found to contain a mass of needle-shaped crystals (see accompanying microphotograph, magnification × 103). A post-mortem examination of the fowl revealed that the kidneys were completely disorganised, being practically "bags of pus". The comb showed dryness and keratinisation, and, in places, ulceration. The liver was found to be devoid of vitamin A by the arsenic trichloride test.

Microphotograph of crystals. × 103.

The condition of the kidneys suggested that crystals in the blood might be uric acid. Under the microscope it was observed that they dissolved completely in dilute potassium hydroxide, but were insoluble in dilute acetic acid and in distilled water. A quantitative estimate of uric acid content was made by Benedict's method. For purposes of comparison, similar tests were carried out on the plasma of 2 fowls, with apparently normal kidneys, fed respectively on the mixed stock diet and on a "control" diet similar to the one described above except that it contained 3 per cent. of cod liver oil. Results were as follows :—

		Uric acid in plasma (mgrms. per 100 c.c.)
Fowl on stock diet	..	12·50
,, "control" diet	..	8·34
,, vit. A deficient diet		375·00

There seems no doubt that the crystals were uric acid. A uric acid plasma content about 30 times greater than values obtained from two fowls with normal kidneys, seemed sufficiently interesting to report. The presence of excessive uric acid in the blood was not, of course, directly due to vitamin A deficiency, but was caused by a pyo-nephrosis consequent on vitamin A deficiency. It need hardly be said that the plasma from the deficient bird, choked with uric acid crystals, could not be used for tissue-culture experiments.

Thanks are due to Dr. W. R. Aykroyd, Director of the Laboratories, for permission to publish this letter.

G. SANKARAN.

Nutrition Research Laboratories,
I. R. F. A., Coonoor,
October 22, 1935.

Fusarium Wilt in Sann Hemp.

IN his recent work[1] Mitra brought forth evidence that under the conditions at Pusa wilts in *Crotalaria juncea* and in *Cajanus indicus* are caused by similar physiologic strains of *Fusarium vasinfectum*. Although the isolates from these two hosts were able to cross inoculate each other, they always failed to infect cotton and *vice versa*.

In their study of the Fusarium wilt in sann hemp, the results of which will be published separately, the present writers had obtained evidence that *Fusariun vasinfectum* was a highly specialised species and in no case did the form on sann hemp pass to pigeon pea, and *vice versa*. These results were contrary to those reported by Mitra, and it was therefore decided to test the correctness of Mitra's conclusions by a series of well-designed experiments. Cultures of *Fusarium vasinfectum* from sann hemp and pigeon pea grown in Pusa and in its neighbourhood were secured through the kindness of Dr. Mitra, and were compared with similar cultures obtained locally. The seeds of a wilt-resistant type, T. 80, and of a susceptible type, T. 5, of pigeon pea were also secured from Pusa.

Cross inoculation experiments were made in soil temperature tanks of Wisconsin type at 28° C., the optimum temperature for the development of wilt. In all cases seeds of sann hemp and pigeon pea were surface-disinfected before sowing in pots. In these experiments cultures of *Fusarium vasinfectum* from sann hemp did not infect pigeon pea and *vice versa*, although control plants in all cases gave a high percentage of deaths.

These results will be reported in detail separately.

B. N. UPPAL.
N. T. KULKARNI.

College of Agriculture,
Poona,
November 6, 1935.

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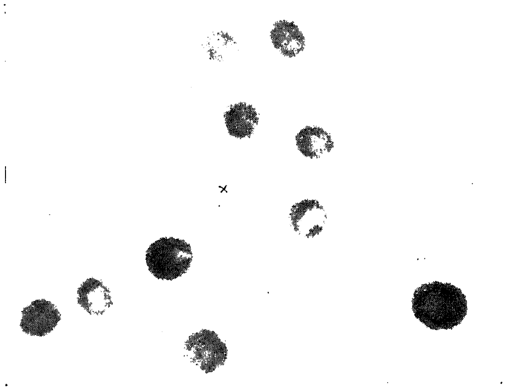
[1] Mitra, M., *Ind. Jour. Agric. Sci.*, 1934, **4**, 701–714.

Dummy Pollen.

IN the course of the examination of innumerable pollen grains in many varieties of *Sorghum* since 1931, a peculiar kind of pollen was met with. An examination of pollen grains under the microscope shows constantly a few grains devoid of solid contents (see Figure). In size they are comparatively small (31 μ to 34 μ). Due to the pressure of the sap inside, they are not shrivelled but retain normal shape. They do not germinate and usually plasmolyse in the culture medium. Pollen studies have not, so far as we are aware, recorded non-germinating pollen of this peculiar type. Similar pollen has been met with in the allied wild grasses, *Andropogon annulatus* and *Andropogon pertusus*, L. In the eight different varieties of *Sorghum* examined, the incidence of this pollen ranged from 2·3 to 13·5 per cent. In the day flowering *S. margaritiferum* it was only 0·4 per cent. The higher types of cultivated *Sorghum* had a lower percentage of this Dummy Pollen. Dummy Pollen is slightly less in the anthers at the base of the earhead.

In the other millets this pollen is met with in *Pennisetum typhoides*, Stapf and Hubbard (also a millet of African origin), which like



× Dummy pollen in *Sorghum*. × 150.

Sorghum has both hermaphrodite and antheriferous flowers. Instances have been met with in both *Sorghum* and *Pennisetum* in which a non-dehiscence of anthers proved to be due to an extreme paucity of this Dummy Pollen, it being under one per cent. in the non-dehisced ones, and over seven per cent. in the dehisced ones. This points to the probable rôle of this Dummy Pollen as a specialisation ensuring dehiscence in these predominantly night-flowering millets. An experience has been met with in which this poverty of Dummy Pollen and the attendant non-dehiscence of anthers proved a simple recessive to the presence of the normal proportion of such pollen and the consequent dehiscence of anthers. A fuller account of this experience is being published elsewhere shortly.

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Coimbatore,
October 19, 1935.

Forked Awns and Leaf-Blades in Sorghum.

AMONG cereals, maize and sorghum have big leaf-blades. These blades have an entire margin and a single central, well-marked midrib running their entire length. This midrib occasionally forks into two

Fig. 1.

(G. N. Rangaswami Ayyangar and P. Subramanyam, 1930).[1] A second aberration in the leaf-blade of sorghum has been met with in some selections. This occurred in three single plant selections from a variety from Bihar (India) and in five single plant selections taken from Kafir imported from America. The aberration is a disturbance in the entirety of the margins of the leaf. In the two halves of the blade there appear deep marginal indentations giving the leaf a tri-dentate appearance (Fig. 1).

Forking occurs usually in the apical third of the leaf, sometimes in the middle third and rarely in the basal third. It forks usually in one leaf of the adult plant and rarely in two leaves. In one instance three leaves in a plant manifested this forking. The forking may show in any leaf of the plant from the flag downwards. It tended to show a little more frequently in the eighth or ninth leaf from the top. Leaves of side-shoots may also fork. In the population examined, 5–13 per cent. of the plants in Kafirs and 26, 30 and 32 per cent. in the three Bihar families manifested forked leaves.

Of the eight families, the five Kafirs were awnless. The three Bihar pure lines were awned. An examination of the awns showed that in every ear-head some of the awns forked in degrees. Ten ear-heads were examined in detail and each ear-head had an average of 1350 awns. Of these an average of 8 proved to be forked awns (Fig. 2). The forking varied from a slight

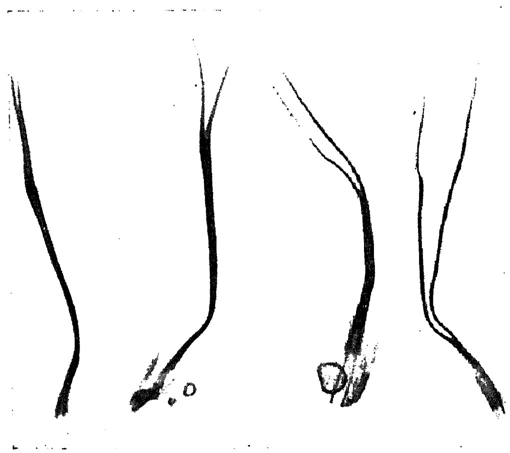

Fig. 2.

bifurcation at the extreme tip of the subule to an extension of the forking to the whole of the subule. In some cases the forking extended to the base of the column. Narrow as the awn is, the forking did not halve the thinness, but each awn of the fork retained the usual narrow width, so much so that in the unforked portions they were noticeably wide.

As in the case of midrib forking, the manifestation of this forking of the leaf-blade need not appear in every plant, nor in every leaf. If it does not manifest in the adult stage, evidences of its presence are betrayed by the leaves of the seedlings. In one pure line six selections that showed forked leaves in the adult plants and three that did not show forked leaves, were selected and germinated. Instead of the usual 95 per cent. of normal germination, all these gave only 75 per cent. In every one of the selections about 8 per cent. of the seedlings showed forking in one or other of the first four seedling leaves. Since all of them gave some plants with forked leaves, this character must have been nascent in the 3 adults that did not show it. In the seedlings the forking, when it showed, was most frequent in the first leaf and next in the second leaf. The peculiarity of the forking in the first two leaves that lacked a well-defined midrib was, that the forking split the blade into two. When this forking was intense it easily invaded the leaf-sheath past the nebulous ligular zone. In 20 instances splitting of the coleoptile was noted. None of these 20 seedlings survived.

This concurrent manifestation of a very rare, probably atavistic, abnormality in two such homologous organs as the leaf-blade and the awn is interesting.

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[1] *Madras Agric. Jour.*, 1930, **18**, 526-530.

Fate of the Embryonic Membranes in Insects.

THE formation of two embryonic membranes, the amnion and the serosa, is characteristic of insects, although in exceptional cases one or both of these membranes may be absent. Regarding their fate, four main types have been so far recognised, *viz.*, involution through the formation of a dorsal amnio-serosal sac ; involution of the amnion with the retention of the serosa ; involution of the serosa with the retention of the amnion; and finally, retention of both the amnion and serosa (*vide* Imms).[1] In all these cases, except the last one, the membranes degenerate some time before hatching. The dorsal organ may be formed from the amnion or the serosa or both.

In the Tettigonids *Xiphidium* and *Orchelimum* (Wheeler)[2] and in the Mantid *Paratenodera sinensis* (Hagen)[3] a third embryonic membrane, the indusium, occurs besides the amnion and the serosa. In the Tettigonids a single dorsal organ is formed from the indusium, while the other two membranes are dissolved into the yolk. In *Paratenodera*, on the other hand, *two* dorsal organs are formed, one from the serosa and the other from the indusium, while the amnion degenerates ; this formation of two dorsal organs is unique among insects.

In some of the parasitic Hymenoptera, a single, peculiar membrane, the throphamnion, is formed. It is not comparable with the other embryonic membranes and appears to be a structure *sui generis*, being formed, in some cases, from the polar bodies (Silvestri).[4] In most cases it degenerates, but in some the cells dissociate from one another, round themselves and increase in size and live for a long time in the body fluid of the host where they serve as food for the parasitic larva. A similar fate occurs in regard to the serosa of several parasitic Hymenoptera and evidence thereto has been marshalled recently by Jackson.[5,6]

It will be seen from the above summary that no case has so far been reported in which a portion of the serosa completely degenerates whereas the other portion persists until hatching. During my investigations on the embryology of the European Migratory Locust, *Locusta migratoria* L., I have discovered such a condition. During blastokinesis or turning round of the embryo, the amnion and the serosa rupture. The whole of the former forms a provisional dorsal closure of the embryo and then quickly degenerates. The serosa, on the other hand, is divided into two portions. By far the largest portion of it goes to form the dorsal organ, while a very small, saucer-like area (Fig. 1, *Q*) remains at the posterior or micropylar pole of the egg and persists until hatching. This area may be called the *posterior serosal patch* and has so far not been described in any other insect. Further, it is interesting to note that this posterior serosal patch does not remain unchanged, but undergoes definite changes of organisation. At first the cells of this area are irregularly arranged. After about two days (at 33° C.) of its separation from the main serosal mass, it shows (Fig. 2) a bi-layered arrangement of its cells, with a rather indistinct space (Fig. 2, *O*.) in between,

This arrangement persists until hatching when the posterior serosal patch is cast off with the egg-shell.

Finally, I should not fail to point out that the occurrence of this phenomenon, *viz.*, the

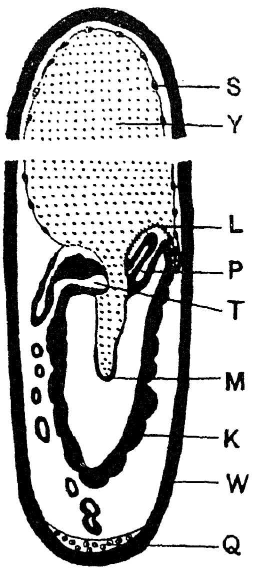

Fig. 1.

Longitudinal vertical section of an egg of *Locusta migratoria* during blastokineses. Diagrammatic. × 22.

K, embryo; *L*, amnion; *M*, splanchnic mesoderm and provisional dorsal closure; *P*, proctodæum; *Q*, posterior serosal patch; *S*, serosa; *T*, stomodæum; *W*, egg-wall; *Y*, yolk.

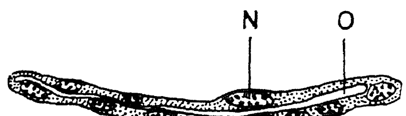

Fig. 2.

The posterior serosal patch from a longitudinal section of an egg of *Locusta migratoria* about two days after blastokinesis. Note the bi-layered arrangement of the nuclei with a cavity in between. × 240.

N, nucleus; *O*, cavity.

persistence of the posterior serosal patch until hatching and the degeneration of the rest of the serosa long before hatching, provides us in the locust a very suitable material for the investigation of an interesting and important problem of Entwicklungsmechanik. Is the degeneration of the anterior portion of the serosa induced by its association with the yolk at the cephalic end of the embryo? Two methods of attack are possible for the solution of this question. The small posterior serosal patch could be transplanted near the cephalic end of the embryo in the neighbourhood of the dorsal organ, and observations made as to whether it degenerates there or persists as in its original place. I have performed several such experiments without success. The difficulty lies in the fact that the locust egg invariably dies a few hours after it is experimented upon. In view of this difficulty for the solution of which I, at present, cannot see any way, the second method of attack, which I have not so far tried, appears to be much more hopeful. It would be interesting to know whether these two portions of the serosa which behave so differently in the living egg would do the same in *in vitro* cultures. Artificial culturing of insect tissues is extremely difficult because it is by no means easy to obtain sufficient quantities of a suitable culture medium. For this purpose I would refer to the papers of Goldschmidt[7] and Frew[8]. Once a suitable culture medium is obtained, I have no doubt that the serosa would provide an exceptionally good material for *in vitro* cultures.

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September 14, 1935.

[1] Imms, A. D., *A General Text-Book of Entomology* 1934, 3rd Ed., London.
[2] Wheeler, W. M., *J. Morph.*, 1893, **8**.
[3] Hagen, H. R., *J. Morph.*, 1917, **30**.
[4] Silvestri, F., *Boll. Lab. Zool. Portici.*, 1906, **1**; 1921, **11**.
[5] Jackson, D. J., *Proc. Zool. Soc.*, London, 1928.
[6] Jackson, D. J., *Nature*, 1935, **135**.
[7] Goldschmidt, R. *Biol. Centralb.*, 1916, **Bd. 36**.
[8] Frew, J. G. H., *Br. Jr. Exp. Biol.*, 1928, **6**; 1929, **6**.

The Respiratory Mechanism of the Frog.

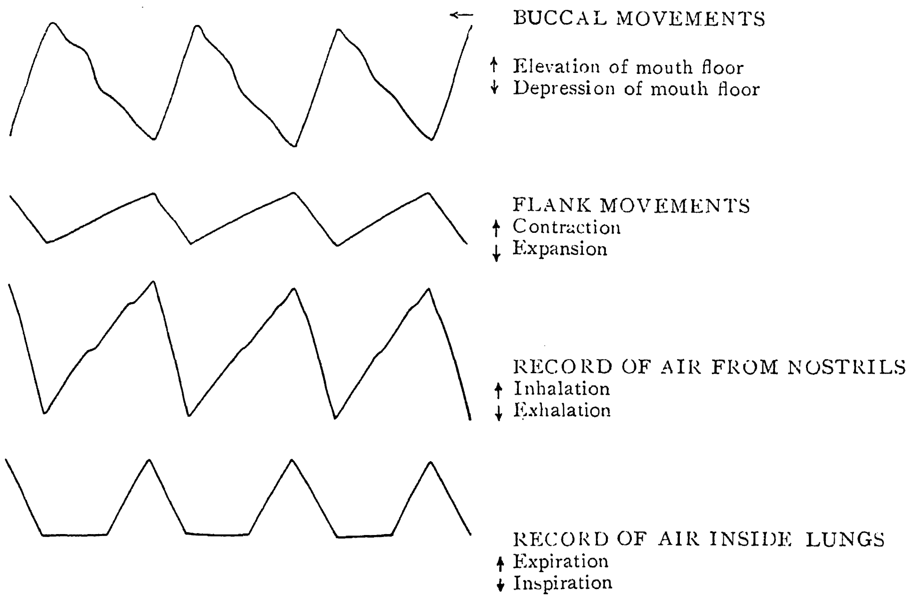
EXCEPT Wedenski and Willem (1918), all others, Gaupp (1900), Baglioni (1901), Bruner (1914), Goppert (1903) and Heinemann (1884), appear to have made no experimental observation; and of the former two, Willem alone has used the graphical method. According to Gaupp, the two processes—expiration and inspiration of air into the lungs—are preceded by a third process—aspiration of air into the mouth. This account does not explain the exit of air

from the mouth. Others, principally Willem, therefore describe two phases (buccal ventilation and pulmonary ventilation) taking place alternately. Almost all accounts state or imply that the lungs and the mouth are ventilated one after the other. Experiments show that they are ventilated simultaneously and that the breathing mechanism is much simpler than has been described hitherto.

The movements of the flanks were recorded on smoked paper and it was found (*a*) that they were uninterrupted, continuous and regular; (*b*) that they are of uniform magnitude. The buccal movements when similarly recorded on smoked paper showed that they were also continuous and uniform. A simultaneous record of both the buccal floor and the flanks showed that when the mouth-floor is raised, the flanks distend and when the flanks contract the mouth-floor is lowered. It is inferred from this that when the buccal floor is elevated, the mouth cavity is reduced and the air is pumped into the lungs and that when the body wall contracts, the air is pressed out of the lungs into the mouth.

The opening and closing of both the nostrils as well as the glottis was observed by graphical records of the air currents. The air going in and out of the nares was led into a tambour by a mask applied to the snout and was recorded—the graph showed uninterrupted inhalations and exhalations. By taking this record of air along with the movements of the buccal floor, it was found that when the mouth floor was raised, the air was exhaled and was inhaled when the mouth floor was lowered. The hyoid apparatus and associated muscles are capable of raising the buccal floor.[1] The air currents were also recorded with the movements of the flanks and the graphs showed that when the air goes out of the nostrils (exhalation), the flanks dilate (inspiration) and when the flanks collapse (expiration), the air enters the nostrils (inhalation). The closing and opening of the glottis was observed by anæsthetising a frog and introducing a slender tube into each lung and leading the air in the lungs into a tambour and thus recording the entrance and exit of air from the lungs. This graph also showed regular and uniform expirations and inspirations.

Scheme of records to illustrate the synchronism of various movements concerned in the respiration of frog.



Putting together the tracings of the buccal movements, flank movements, air currents from nostrils and from lungs the interpretation of the respiratory mechanism would be as follows: When the buccal floor is lowered, outside air is inhaled through the nostrils into the mouth cavity while the air inside the lungs is sucked (and also squeezed by the body wall) through the glottis into the buccal cavity. Thus the fresh and the impure air mix in the mouth chamber. When the buccal floor is elevated, this mixed air rushes out of the nostrils as

well as into the lungs. The graphs of the air currents make it clear that neither the nares nor the glottis are completely closed for any long interval. They constrict in such a way that the buccal floor oscillations increase or decrease the pressure in the mouth chamber.

The rôle played by the body wall and the elasticity of the lungs in this mechanism can be demonstrated by preventing the mouth of a frog from closing and thus throwing the buccal floor out of action. Graphical records of the flanks show a series of expirations followed by no inspiration—until the expirations become extremely feeble. Thereafter each weak expiration is followed by a feeble passive inspiration and the frog continues to breathe in this way. This co-operation of the buccal floor and the body wall serves to lead up to the reptiles the more primitive members of which employ the buccal floor as well as the ribs to ventilate the lungs.[2]

C. P. GNANAMUTHU.

Madura,
October 28, 1935.

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[1] *Rec. Ind. Museum*, June 1933, Anatomy of the tongue of *Kaia hexadactyla*.

[2] *Curr. Sci.*, Oct 1933.

The Sub-central Foramina of the Squamata.

SINCE writing a note[1] on the presence of paired apertures on the ventral aspect of the vertebral centra in the common house-gecko, *Hemidactylus flaviviridis* Rüppel, I have been on the look-out for previous references to them in zoological literature. A consultation of such standard text-books of zoology as Sedgwick[2], Wiedersheim and Parker[3], Hertwig and Kingsley[4], Kingsley[5], Reynolds[6], Parker and Haswell[7], Hyman[8], Goodrich[9] and de Beer[10], shows that these apertures have somehow escaped the general observation of many eminent zoologists. As pointed out by Ramanujam and Ramaswami[11], however, Owen[12] recorded them for the Ophidia long before Mookerjee and Das[13]. More recently, Camp[14] has studied and sketched the vertebræ of 22 species of lizards for this feature. He says:

"The size of the intervertebral canals, large in the Geckonidæ and Xantusiidæ, undergoes reduction in the more advanced groups. The paired sub-central foramina, present in geckos, pygopodids and amphisbænians.... appears less frequently among the Scincomorpha and are absent in the higher anguimorphs and in the chamæleons."[15]

This statement seems to imply that the presence and size of these apertures is a primitive feature in lizards, and that it, therefore, adds to the "Paleotelic Weight"[16] of the animals in which it is found. If this notion is right, it is a significant fact that these apertures in *Hemidactylus* are larger in size relatively to the size of the whole centrum than in the vertebræ of the four species of Geckonidæ, figured by Camp, *viz.*, in *Thecadactylus rapicauda*, *Tarentola cubana*, *Sphærodactylus macrolepis* and *Coleonyx variegatus*.

Goodrich[17], although he makes no mention of the presence of sub-central foramina in this work, gives an instructive diagram about the "relations of *sclerotomes* and development of *vertebral column* in *Amniota*", which seems to suggest that these apertures are really intersegmental in position and represent the sclerotomic segmentation of the earlier stages in the case of the adult. The position of the intersegmental artery in his diagram (Fig. 1) coincides very well with the

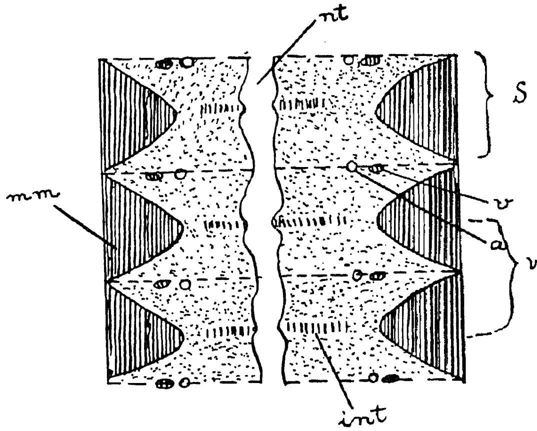

Fig. 1.

Diagram illustrating relations of *sclerotomes* and development of *vertebral column* in *Amniota* (simplified from Goodrich).

a, intersegmental artery; *int*, intervertebral ligament; *mm*, myomere; *nt*, notochord; *S*, region between two transverse broken lines occupied by one body segment; *v*, intersegmental vein; *vs*, region occupied by one vertebral segment composed of a half-sclerotome from each of two consecutive segments.

position of the sub-central foramina in *Hemidactylus* (Fig. 2) and other Squamata. Thus these apertures are probably reminiscent of a former condition and may be regarded as primitive features.

Granting the intersegmental position and the primitive nature of these foramina, it

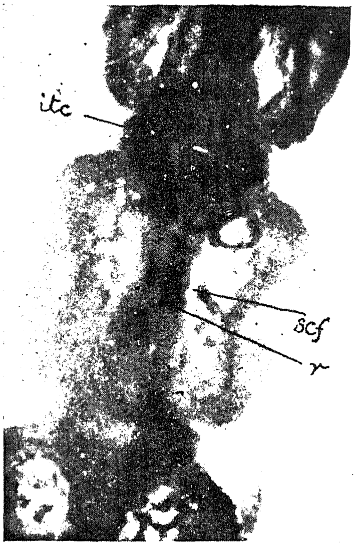

Fig. 2.

Photomicrograph of the ventral aspect of the centra in *Hemidactylus flaviviridis*.

itc, intercentrum ; *r*, median ridge ; *scf*, sub-central foramen.

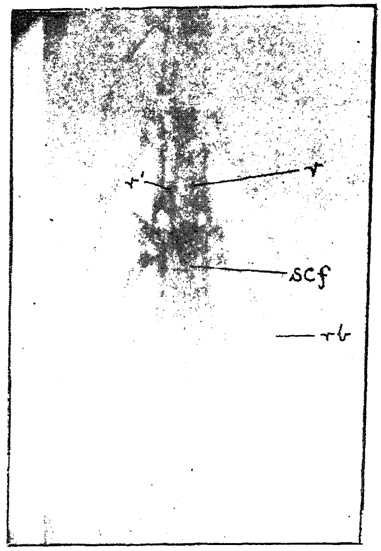

Fig. 3.

Photomicrograph of the Vertebral Column of *Typhlops braminus* from ventral aspect.

r, r', ridges ; *rb*, rib ; *scf*, sub-central foramen.

would be interesting to find out whether any types of the Amphibia, extinct or living, show these apertures at any stage of their development. An examination of the vertebræ of the extinct genus *Arœoscelis* Williston, which is said to represent the ancient stem from which the Lacertilia arose,[18] might be worth while in this connection, as also a fresh scrutiny of the vertebræ of *Sphenodon*. In the latter case, I might mention that Günther[19] and others do not make any mention of these apertures. I hope that those zoologists who have access to this type of materials will throw some light on this question.

In the present stage of our knowledge, it is impossible to be certain whether the *single* sub-central foramen of *Typhlops*[20] is actually homologous to the *paired* apertures found in lizards and in some snakes. I am, however, inclined to believe that it is not. Recently, I prepared two alizarin-stained skeletons of this snake to confirm Mookerjee and Das's findings, and my attention was especially attracted by two differences in this connection. In the first place, the apertures in *Typhlops* (Fig. 3) are placed far more anteriorly than those in *Hemidactylus*, being just a little behind the anterior ends of the centra. Secondly, two slight ridges in the case of *Typhlops* start at the posterior end of the ventral aspect of each centrum and converge towards each other as they run forwards, the single sub-central aperture being situated where they should meet together. In *Hemidactylus*, on the contrary, there is a prominent single median ridge, situated longitudinally on the ventral aspect of each centrum, and the apertures in question lie one on each side of it.

An examination of the vertebræ of two other families of Snakes—*Boidæ* (*Eryx jaculus* Linné, *Python molurus* Linné) and *Colubridæ* (*Ptyas mucosus* Linne', *Naia tripudians* Merr.)—shows the presence of *paired* (not single) sub-central foramina, and thus the case of *Typhlops*, as far as has been investigated up to the present, is a solitary one amongst the Ophidia. However the sketch of the ventral aspect of a vertebra of the extinct snake *Palæophis typhæus* Owen, as given by Lydekker,[21] raises the suspicion that this snake had not two sub-central apertures like the *Boidæ* and the *Colubridæ*, but a single aperture which was situated nearer the posterior than the anterior end of the centrum. This feature, if confirmed in actual specimens of the vertebræ, might prove important insomuch as it would make *Palæophis* appear to be related to the *Typhlopidæ* rather than to the *Pythoninæ*, with which latter it is believed to have affinities.

Some time back, I requested Mr. E. R. Gee, Director, Geological Survey of India, to

scrutinise the vertebræ of *Palæophis* for this feature, but unfortunately the palæontological collection in his charge does not include any vertebræ of extinct species of Snakes and Lizards. I hope, however, that some one else who has access to such material, might examine them. I am grateful to Mr. Gee for kindly examining the fossil vertebræ of several *extant* species of Snakes for me and for reporting the presence of paired appertures on the ventral aspects of their centra. "The apertures," he says, "are in the form of narrow slits."

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St. John's College,
Agra,
October 3, 1935.

[1] Mahendra. B. C., "On the Peculiar Apertures in the Vertebral Centra of *Hemidactylus flaviviridis* Rüppel," *Curr. Sci.*, 1935, **1**, 34.

[2] Sedgwick, A., *A Student's Text-book of Zoology*, 1905, II.

[3] Wiedersheim, R., *Comparative Anatomy of Vertebrates*, adapted by W. N. Parker, 1907.

[4] Hertwig, Richard, *A Manual of Zoology*, translated by J. S. Kingsley, New York, 1912.

[5] Kingsley, J. S., *Comparative Anatomy of Vertebrates*, London, 1912.

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[11] Ramanujam, S. G. M., "Vertebral Centra of *Typhlops braminus*," *Curr. Sci*, 1933, **2**, 178-79.

[12] Owen, R., *Comparative Anatomy o Vertebrates*, 1886, **1**, 53.

[13] Mookerjee, H. K., and Das, G. M., "On the Peculiar Apertures in the Vertebral Centra of *Typhlops braminus*," *Proc. Zool. Soc.*, 1933, 283.

[14] Camp, C. L., "Classification of the Lizards," *Bull. Amer. Mus. Nat. Hist.*, 1923, **48**, 289, 481.

[15] Camp, C. L., *op. cit.*, 344.

[16] Camp, C. L., *op. cit.*, 332.

[17] Goodrich, E. S., *op. cit.*, Fig. 62, p. 56.

[18] Williston, S. W., "The Phylogeny and Classification of Reptiles," *Jour. Geol.*, 1917, **25**, 309-321.

[19] Günther, A., "Contribution to the Anatomy of *Hatteria (Rhynchocephalus*, Owen," *Phil. Trans. Roy. Soc.*, 1867, B. **157**, 604 606.

[20] ...erjee, H. K., and Das, G. M., *loc. cit.*

...ichard, "Catalogue of the Fossil Re-...ia in the British Museum," 1888, **1**,

A Contribution to the Stratigraphy of Bagh Beds.

BAGH BEDS representing the marine facies of the Cretaceous of the Narbada valley, occur in several detached areas on the northern side of the Narbada from Barwai on the Khandwa-Indore railway line on the east to Wadhwan in Kathiawar on the west. The earliest references to the fossiliferous limestones of these formations are by Dangerfield in 1818, and by Colonel Keatinge in 1856[1] but the geology of the areas was first worked out by W. T. Blanford[2] and later studied in detail by P. N. Bose.[3] These beds occur as inliers in the Deccan Traps, the principal exposures being those near Chirakhan, Bagh and Kawanth. According to Blanford and Bose the stratigraphical sequence obtaining in these areas is as follows :—

		Position of the new beds
Deccan Trap.		Fossil Wood and Breccia Zone
Bagh Beds	(Upper) Coralline Limestone	
	Deola-Chirakhan Marl	
		Lower Coralline Limestone
	Nodular Limestone	
	Nimar Sandstone	
Gneisses ; Gondwanas, etc.		

During a short visit to these formations in the Chirakhan area, a few months back, the authors have traced a new bed in the above sequence in this region : A bed of bryozoan limestone, 3–5 ft. thick, occurring between Nodular Limestone and Deola-Chirakhan Marl and provisionally named here as Lower Coralline Limestone.

This horizon has been traced round Badiya, Chirakhan, Sitapur, Audiyapur and Deola, the best development, however, occurring on hillocks near Deola and Sitapur. It is separated from the (Upper) Coralline Limestone by the bed of soft Deola Marl which on differential denudation has left the Coralline Limestone bands, both at the top and at the base, as projecting rock masses. In certain places, the Lower Coralline Limestone band is very thin and inconspicuous and as such escapes notice. It is a hard granular rock, brownish yellow in colour and is full of bryozoa. The fossils provisionally identified from this horizon include *Eschara*, *Ceriopora*, *Thamnastræa*, *Hemiaster*, small

rhynchonellids, *Placenticeras*, *Inoceramus*, *Cardium*, *Venus*, etc.

The Upper Coralline Limestone of the Chirakhan-Deola area resembles the Lower Coralline band to a great extent in lithology and in external appearance, and but for the intervening band of Marl, cannot be easily distinguished. In certain western exposures of the Bagh Beds, Coralline Limestones are reported to be capping Nodular Limestone with the supposed intervening Marl missing, its absence being attributed to its soft nature and its consequent denudation. In the light of the present discovery it appears very probable that the Coralline Limestones of the western exposures are in their normal position and correspond to the Lower Coralline Limestone horizon of the Chirakhan area and not to the (Upper) Coralline Limestone as suggested by the previous authors.

The discovery of a lower horizon of Coralline Limestone therefore necessitates the amendment of the stratigraphical sequence of the Bagh Beds as shown in the above Table.

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September 15, 1935.

[1] *Jour. As. Soc. Bengal*, 1858, **27**.
[2] *Mem. G.S.I.*, 1869, **6**, Pt. 3.
[3] *Mem. G.S.I.*, 1884, **21**, Pt. 1.

On a Fossil Wood and Breccia Zone in the Deccan Trap in Deola-Chirakhan Area, Central India.

DURING a recent visit to the Chirakhan area, we have noticed more or less continuous zone of fossil wood and breccia at the contact of Traps and the Bagh Beds. It is a very definite horizon being met with in almost all the localities wherever the Bagh Beds are overlain by the Traps. It has a sharp junction with the underlying coralline limestones but has no such demarkation on its upper limit where it merges into the normal traps.

In most places this zone is characterised by the exclusive abundance of fossil wood strewn over the surface, in a loose condition, under a thin covering of trappean soil. Fossil wood specimens, which to all appearances are dicotyledonous in nature, range in size from small fragments to huge tree trunks about 4 ft. in diameter and more than 40 ft. in length. The wood has been completely jasperised and is left with practically no trace of internal structure; the gross surface features and sometimes the rings of growth are very clearly seen.

In certain localities as near Badiya, Phutabaodi and Chirakhan, in addition to fossil wood, we also observe in the same zone an extensive occurrence of breccia in the form of a scattered band irregularly spread over the surface. Anything approaching a regular band occurs only at Badiya. The rock is a hard indurated type of breccia composed of variously sized angular or sub-angular fragments of limestones, sandstones, jasper and pieces of fossil wood, all heterogeneously cemented in a calcareous and ashy material. The fragments vary in size from tiny grains to blocks more than a foot in diameter. This unassorted and fragmental nature of the material may be due to absence of any sorting action of water or may indicate formation of the rock *in situ*. The presence of the ash in the matrix demonstrates its close association with the volcanic activity as also does the presence of jasper which is usually found in steam cavities in lavas.[1] The complete loss of internal structure in the fossil wood may be due to the heat of contact with the lava or due to rapid replacement of wood tissues by heated solutions. These considerations together with the strictly sub-trappean position of the band in the field strongly suggest that the formation of the breccia and the fossilisation of the wood are very intimately connected with the activity of the lava flows. It is not thus unlikely that the forest growth together with the rock debris was overwhelmed by volcanic ash and was subsequently buried under a lava flow, the heated fluids bringing about the cementation of the debris into a hard breccia and also the fossilisation of the plant remains with almost complete obliteration of the structure, the cold surface waters having little part in the formation of either. The fossil wood and breccia thus characterise the lowest flows of the Deccan Trap in this region.

K. P. RODE.
Department of Geology,
Benares Hindu University,
September 26, 1935.

[1] Goodchild, 'Precious Stones,' 1908, pp. 165, 175.

The Age of the Inter-Trappean Beds near Rajahmundry.

IN the course of a recent examination of the several inter-trappean exposures near Kateru, Pungadi and Dudukur, we have made two important observations which throw some light on the age of the Deccan traps—a subject on which there has recently been some comment by Dr. Sahni[1] and Dr. Fox.[2]

Thin sections of the limestones forming the lowest beds of the Deccan inter-trappean series near Pungadi and Dudukur have revealed, among other fossils, remains of algæ belonging to the family Dasycladaceæ. Some of these slides were sent to Dr. Julius Pia (of the Natural History Museum, Vienna) for identification, and he has recognised *Acicularia* as the most common of these algæ. It is well known that, though members of the family Dasycladaceæ were fairly common throughout the Mesozoic, *Acicularia* is essentially a Tertiary form. This find of a Tertiary fossil alga from these beds is of great significance, especially in view of Dr. Sahni's discovery of fossil plants of Tertiary affinities among the fresh water inter-trappeans of Nagpur-Chhindwara region.

Among the inter-trappean beds near Kateru, we have noticed the occurrence of numerous Charophytic remains in an excellent state of preservation. Among these the following species of *Chara* have been tentatively identified: *C. Wrightii*, *C. helicteres*, *C. cælata*, *C. vasiformis*. *C. turbinata*, and *C. strobilocarpa*: and all of these are seen to be of distinctive Tertiary affinities.

In view of the fact that the traps near Rajahmundry must be considered as belonging to the lowest division of the Deccan traps as a whole, the two palæobotanical evidences we have cited above appear to be definitely in support of Dr. Sahni's suggestion that the Deccan trap flows are of an early Tertiary age.

S. R. NARAYANA RAO.
K. SRIPADA RAO.

Department of Geology,
Mysore University,
November 3, 1935.

[1] *Curr. Sci.*, 1935, **3**, 134.
[2] *Curr. Sci.*, 1935, **3**, 428.

Phosphatases of the Brain.

Two phosphatases, distinguished as acid and alkaline phosphatases and characterised by differences in optimal p_H are known to occur together in certain organs of the body. Thus, liver, kidney (Bamann and Riedel[1]) and spleen (Davies[2]) contain the two phosphatases. On the other hand, bone, intestines, blood plasma and erythrocytes contain only one type of the enzyme.

The phosphatases of the brain have not been investigated from this point of view. The present note relates to the presence and behaviour of two phosphatases in the brain (of the sheep). The alkaline phosphatase has an optimal reaction of p_H 9·6, and is activated by magnesium ions, the increases in activity exceeding 100 per cent. when magnesium is added in optimal quantities (0·001 M—0·002 M); the acid phosphatase which has an optimal reaction of p_H 5·0 is not activated by magnesium and resembles the urine[3] and salivary[4] phosphatases. The two phosphatases of the brain are thus similar to those of the other organs, in their behaviour towards magnesium.

Waldschmidt-Leitz and Nonnenbruch[5] consider that the alkaline phosphatase is typical for all organs; they suggest that the acid phosphatase demonstrated by Bamann and Riedel[1] is really due to the presence of erythrocytes in their extracts. This, however, appears to be untenable because the erythrocyte phosphatase is activated by magnesium salts, while the acid phosphatase extracted from the brain and the organs is not so activated.

Further work on the phosphatases of the brain is in progress.

K. VENKATA GIRI.
N. C. DATTA.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
November 6, 1935.

[1] Bamann and Riedel, *Zeitschr. f. Physiol. Chem.*, 1934, **229**, 125.
[2] Davies, *Biochem. J.*, 1934, **28**, 529.
[3] Kutscher, *Zeitschr. f. Physiol. Chem.*, 1935, **235**, 62.
[4] Giri, K. V., unpublished work.
[5] Waldschmidt-Leitz and Nonnenbruch, *Naturwissen.*, 1935, **23**, 164.

A Note on the Jassid Bugs of Paddy.*

Introduction.

PADDY (*Oryza sativa*) is subject to the attack of about three dozen insect pests of which eight or nine, such as the paddy stem borer (*Schœnobius incertellus*, W.), the paddy swarming caterpillar (*Spodoptera mauritia*, B.), the rice bug (*Leptocorisa acuta*, Th.), the rice grasshopper (*Hieroglyphus banian*, F.), the rice case-worm (*Nymphula depunctalis*, Gr.), the paddy gall-fly (*Pachydiplosis oryzæ*, W.), the rice Hispa and Leptispa, are major pests. The Jassid bugs of paddy, however, come under the group of minor pests. Normally they do not do much harm to the plant but, in certain years, cause fairly serious damage.

Jassids—What these are.

Jassids are plant bugs belonging to the sub-order *Homoptera*, order Rhynchota. These have sucking type of mouth parts and two pairs of wings. They have an incomplete metamorphosis. Eggs are laid on the tender portions of the plant and the young ones which hatch out—nymphs—and also the adult bugs suck the juice of the plants and, if found in large numbers, the affected portions fade and dry up as a result of the attack.

Species of Jassids affecting Paddy.

Four species have been known to affect paddy in the Madras Presidency. These are the green-spotted Jassid (*Nephotettix bipunctatus*, F.); the white Jassid (*Tettigoniel spectra*, D.); *Erythroneura subrufa*, M., and *Deltocephalus dorsalis*, M. Of these, the first two are found in almost all paddy areas while the third one is commonly noticed in North Malabar and the last in the Northern Circars.

Control Methods.

Collection of nymphs and adults with hand-nets or bags have been found to be successful against the pest. The use of sticky winnows is yet another method advocated in some places. Light traps have also been tried especially against the green-spotted Jassid. The use of tobacco dust mixed with lime has given successful results against nymphs.

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Lawl y Road P.O., Coimbatore,
October 29, 1935.

* In view of the recent outbreak of *Jassid* pest of paddy in Godavari delta, this account given by Mr. C. Cherian will be of interest (Ed.).

A Note on the Locust Position in North-West India and Baluchistan during the Current Year—1935.

EXPERIENCE gained during the last three years has shown that the multiplication of the Desert locust is entirely dependent on favourable rainfall in its breeding areas. During the winter and spring of 1934–35, early, wide-spread and heavy rains were received throughout the winter-rainfall areas of Baluchistan and Persia, and many of the coastal areas, such as Jask, Gwadar, Pasni and Ormara, recorded more than 10 inches of rain between December 1934 and April 1935. In the wake of such favourable rainfall, the locust was noticed to begin egg-laying early in February, and by April 1935 adult locusts of the new generation were found to have come into existence in fairly large numbers.

In the hinterland of Mekran, two cases of damage to *Jowari* crops by bands of gregarious hoppers were reported in June and July respectively, and on investigation, it appeared as if the hoppers had come into existence as a result of concentrated egg-laying in the sandy areas close by, by individuals of the first generation, that had been produced in the coastal areas and had, later on, migrated into the interior of Mekran. The adult locusts emerging from the infestations mentioned above are reported to have disappeared after acquiring wings. Since the interior of Mekran becomes an area of high temperatures and low humidity during July, August and September, it is presumed that they flee from such uncongenial conditions in search of better environmental conditions elsewhere.

By about the second week of July, a sudden increment in the numbers of locusts was noticed in several different places almost simultaneously: for example, at

Pasni, Gwadar, Ormara and Sonmiani along the Mekran Coast, in a large number of places in Sind, especially in Dadu, Sukkur, Hyderabad, Karachi and Tharparkar Districts, in Nushki and Kachhi in Upper Baluchistan, in the Khairpur and Bahawalpore States, and in many parts of Marwar, Jaisalmer and Bikaner States. In most cases, the incursion appears to have occurred as an imperceptible immigration of individuals, though in a few places swarms of small size were also reported. It is also noteworthy that a great proportion of the locusts collected after this incursion was found, on biometrical analysis, to show elytron-femur ratios pertaining to the *transiens* and *gregar* types, whereas the individuals found before this event in Sind and Rajputana deserts were mostly of the *solitaria* facies.

There was general rainfall in Western Rajputana and in the Thar portion of Sind during July, and oviposition by locusts was noticed to some extent in these areas in July and August, but during August and September rainfall was greatly restricted. On the other hand, in most parts of Sind and Baluchistan subject to the influence of the monsoon, there was a complete failure of rains, and consequently there was no breeding.

The new generation of locusts made their appearance in September in the desert areas of Sind and Rajputana, but though widely scattered over a large area of desert, locusts were found on the whole to be in comparatively small numbers. Their biometrical ratios, moreover, were noticed to be mostly of the *solitaria* type. Observations made so far appear to indicate that this year's incursion—presumably from a western source—has fizzled out and that at present there is no ground for anticipating the formation of swarms.

During the year 1926, a similar incursion, though presumably of a greater magnitude, occurred at about the same time of the year, and as a result of very heavy summer rainfall throughout Baluchistan, Sind and Rajputana, the resultant breeding was so extensive as to start the last great Locust Cycle of 1926–31. One wonders what might have happened if the current season's monsoon had been heavier and more prolonged.

Y. RAMACHANDRA RAO.

Locust Research Station,
Karachi,
November 1, 1935.

Obituary.

Major Robert Ferguson Stirling (1886—1935).

IT is with deep regret that we have to announce the death, from heart failure on 16th August last at Nagpur, of Major Robert Ferguson Stirling, Director of Veterinary Services, Central Provinces. By his death at the early age of 48, India has lost one of the pioneer Veterinary workers in this country.

Born in 1886, he qualified with distinction as Member of the Royal College of Veterinary Surgeons from the Dublin Veterinary College. Soon after, he accepted an appointment in the Rhodesian Veterinary Service where he lay the foundations for his future interest in tropical diseases of animals. In fact, his thesis for his Fellowship of the R.C.V.S., which he took in 1912, was on the control of East-Coast Fever of cattle.

On the outbreak of the Great War, he joined the Royal Army Veterinary Corps and found active service in France. His army service called for high praise from his superior officers and particularly from Major-General Sir John Moore, K.C.M.G., etc., the then officer commanding the Veterinary personnel of the British Expeditionary Force in France. An appreciation of the late Major Stirling's work published in the *Veterinary Record*, London, by Sir John, is read with pleasure by many of the friends and colleagues of the deceased officer.

He joined the Civil Veterinary Department in C.P. in April 1920 and except for a short break when he was called on to officiate as Pathologist at the Imperial Institute of Veterinary Research, Muktesar, he continued to be in C.P. first as Deputy Director and subsequently as Director of Veterinary Services, C.P. In the latter capacity for well over seven years, he brought into his work scientific and organising capacity of a high order which had been the pride and envy of his colleagues and friends.

His scientific talents which found early vent in the study of East-Coast Fever in cattle, later developed with the limited opportunities for an administrative officer

in this country to the detection of Ranikhet disease in Fowls and the treatment of *Piroplasma gibsoni* in dogs and *P. bovis* in cattle.

His greatest achievement in Science, however, is his work on Rinderpest in cattle and its control. The first two progress reports on this work which appeared in scientific journals were well received by Veterinary workers all over the world and the third and final report which was almost ready for publication, at about the time of his death, will, it is hoped, be published in due course.

Personally Major Stirling was a most amiable man and made many friends amongst Indians. He was further able to induce a great deal of his enthusiasm for work amongst his co-workers and subordinates and to further this object, founded the C.P. Veterinary Association with its own *Quarterly Journal*. The latter had been the means of stimulating the subordinate Veterinary workers into expressing in accurate language the results of their observations of obscure diseases in the field. His energy for work was unbounded and he hardly restricted himself to the prescribed hours for office work. His end was very unexpected. To Mrs. Stirling who was on a holiday in England when the sad event took place and who was all through the late Major's career more than a helpmate to him and to mother Mrs. Stirling, we offer our sincerest condolences.

R. V. P.

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Provash Chandra Basu.

THE sudden death of Mr. Provash Chandra Basu, M.B., M.SC., P.R.S., at the early age of 31 years on Friday, the 6th of September, has cut off a brilliant career at its very outset. Mr. Basu was a very distinguished student, and carried on his studies simultaneously in the Medical College whence he obtained the M.B. degree, and in Anthropology in the Calcutta University for which he was awarded the M.Sc. degree and later the greatly coveted Premchand Roychand Research Studentship. Both in the University and in the Medical College his career was exceptionally brilliant and he was awarded a number of scholarships, medals and prizes. Later, he was also selected by the Government of Bengal for a research scholarship for anthropological and ethnological studies; during the period of this studentship he carried out his work in the Anthropological section of the Indian Museum under the supervision of Dr. B. S. Guha. He was then appointed a research scholar of the Bose Institute, Calcutta and was attached to this institution till his sudden death.

Mr. Basu, as a result of his medical education, was specially suited for detailed anthropological studies and published several papers of importance in the *Journal of the Asiatic Society of Bengal* and in the *Transactions of the Bose Research Institute*, Calcutta. He also collaborated with Dr. B. S. Guha of the Zoological Survey of India in a publication in the *Anthropological Bulletins* issued by the Department, on the human relics recovered from the Naga Hills by the Expedition which was sent in 1926–27 for the abolition of human sacrifice. Special attention may be directed to his work on the Bhuiyas of Maurbhanj, the Racial affinities of the Mundas, and the so-called Pre-Dravidian tribes of India, while his studies on the Anthropological Measurements of the Mundas and Oraons also deserve special mention. In addition, he carried out detailed studies on Burmese crania and collaborated with Dr. Guha in his studies on the prehistoric human remains excavated at Mohenjodaro.

Mr. Basu's early death has unfortunately resulted in leaving his anthropological studies incomplete, but it is hoped that the work which he had so well started at the Bose Institute will be continued.

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Edgar Thurston.

WE regret to record the death early in October when about eighty years old, of Mr. Edgar Thurston, well known as Superintendent of the Madras Government Museum for about twenty-five years, and as the author of *Castes and Tribes of Southern India*, the seven volumes of which, appearing in 1909, laid the foundations of ethnological research in South India.

Thurston was born in 1855 and educated at Eton and in the medical school of King's College, London. He was for some time in charge of the museum of that college, and came to India to take charge of the Madras Museum in October 1885 as its first full-time Superintendent. He seems to have found this Museum in a somewhat chaotic condition, without any very definite policy or aims, a state of affairs which he at once set himself to rectify. For we read in his first Annual Report, "It is wholly beyond the power or scope of a presidential museum to rival the great national museums in the possession of representative collections from different quarters of the globe, and I have

determined to devote my entire attention to the natural history, arts, ethnology, manufactures and raw products of Southern India, accepting only such specimens from other regions as may be sent as donations from time to time, and keeping them entirely apart from the main collections. The necessity for such a course is best illustrated by reference to the geological collections which, while abounding in a chaos of purchased and exchanged specimens of European fossils, is markedly deficient in specimens from the rich fossiliferous beds of the cretaceous system of Southern India." The policy which he thus established proved to be a sound one and, having been steadily pursued ever since, has resulted in the formation of the valuable South Indian collections for which the Museum is now known.

His wide interests and knowledge are indicated by the variety of subjects on which he wrote. These include coins, South Indian batrachians, fisheries and meteorites, as well as a number of papers on Anthropology; and under his guidance all sections of the Museum underwent great development, and the Connemara Public Library was founded with the Museum Library as its nucleus.

From September 1891 to November 1893, he officiated as Reporter on Economic Products to the Government of India in Calcutta. After his return to Madras he was appointed Lecturer in Comparative Anatomy at the Medical College for the year 1895-96, in addition to his permanent appointment. In 1901 he was similarly appointed Superintendent of the Ethnographic Survey of the Madras Presidency, which post he held till its termination in 1909. He finally retired in July 1910, but was absent on leave for some time prior to this.

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Henry Fairfield Osborn.

WE regret to announce the death, at the age of 78, of Henry Fairfied Osborn, the eminent Palæontologist, well known for numerous publications, among which may be mentioned, "The Age of Mammals" (1911), "Huxley and Education" (1920), "Men of the Old Stone Age" (1915), "Origin and Evolution of Life" (1917).

Industrial Outlook.

Some Lines of Development of the Indian Paint Industry.

By N. Srinivasan, M.A.,
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THERE can be no doubt that the production of paint materials is a promising branch of Indian Industry. Its rise has been rather late; barely three decades have passed since it was initiated in the country. The first need of the industry in which practice has out-stripped theory, was a human one: experienced technicians. The second was special plant and machinery which constitute an important element in its establishment. These could not be met.

The advantages possessed by the Indian Industry, however, are many and obvious. It is well supplied with raw materials. It can depend on a large domestic market. Indian manufacturers could experiment under actual conditions to which they can adapt their processes. The creation of confidence in Indian manufactures, noticeable in recent times, is no small comfort to the industry. The Paint trade thus offers a great field of interesting possibilities for future accomplishment. It is true that, like many others, it has been through the trough of depression. But we are told there are indications of a return to a better trade. The new trend of industrial policy of the government is another healthy sign. The importance of technical research as a necessary aid to industrial progress has been realised since the days of the Holland Commission. The co-ordination of efforts in this direction under a unified control has also been very recently secured. With the establishment of a Central Industrial Research and Intelligence Bureau, might be said to begin a new chapter in Indian industrial development.

It may therefore be pertinent to take stock of what progress has been achieved in this particular branch; and indicate or reiterate those future lines of development which might yield to immediate enterprise and research. A detailed review of the

subject is not made. What is attempted is a selection for consideration of a variety of points. These have a general or particular interest when viewed from the following aspects:—(1) The Indian market for Paint products; (2) The natural resources available for exploitation; (3) The present state of technical efficiency in the country.

First take the raw materials. Among Paint vehicles the most important are Linseed and Tung oils. The position with regard to Linseed is strong. As for the other, great expansion is necessary to free the industry from Chinese supplies which are of bad quality and often adulterated. China wood oil possesses some unique properties and is an essential material in present day varnish making. Its ability to dry quick and its compatibility with synthetic resins are being exploited to best advantage. Another important property is its suitability for use with Rosin with which it gives the so-called Spar varnishes. This is of particular interest to the Indian Industry as Rosin is almost the only oleo-varnish gum available in the country. Rosin has hitherto not found favour as a good varnish-making material.

Experimental growing of Tung trees have been undertaken. It was found that the trees do well on Tea estates especially in Assam and Burma. The methods of cultivation of the plant in China are obscure. Systematic research in this aspect remains to be carried out; the soil conditions and methods of culture as affecting the yield of crop and processes of extraction and refining as influencing the quality of the oil. These studies would be of immediate value to the industry in its present endeavour to produce on an economic basis, oil of satisfactory quality. Trials of cultivation could be extended to other areas in the country.

Pigments play by far the most important rôle in Paint production. These could be classified under two heads, natural and chemical. The manufacture of pigments has mostly been undertaken by big Paint concerns for their use. The small consumer has hitherto been dependent on imports and these run high. The development of this line has attractive possibilities as pigments are used in other industries as well.

Among natural pigments, Barytes has a definite place in the stock of raw materials for the trade. The deposits in the Ceded Districts of the Madras Presidency and in Alwar are only too well known. Mainly through lack of initiative the available resources have remained unexploited. No export market can be found for the crude material. The extension of mining operations and the production of the material in various grades in a finely powdered form are most needed. That would destroy dependence on imports which still amount to more than half the consumption.

Lithopone is a chemically prepared white pigment which has assumed interest in recent times. Its advantages are many: excellent colour, great opacity, unique covering power, complete inertness and above all comparative cheapness. To-day its consumption rivals that of white lead. The production of this pigment which has yet to be undertaken in the country is important for the following reasons: It would stimulate mining to a larger extent, of the available deposits of barytes which constitutes the starting material for the manufacture of the pigment. The production of a variety of cheap paints with a Barytes-Lithopone base, particularly for the Indian market, remains to be carefully investigated. The recent tendency is to substitute the zinc oxide in enamels more and more by Lithopone and there is no prospect of the production of the oxide in the country. The complete absence of deposits of whiting—the base for the different types of water paints—would necessitate the substitution of Lithopone. Its unique opacity and covering power render possible its use in conjunction with large proportions of colloidal clay. Good white qualities of this material are forthcoming from different parts of the country. Lastly, mention might be made of the capacity of Lithopone to go with shellac varnishes to yield varnish paints which have special applications.

Lithopone is the mixed precipitate obtained by double decomposition of Barium Sulphide with Zinc Sulphate. Barium Sulphide could be produced by reduction of Barytes. As for the Zinc salt, one has to look elsewhere. It has been suggested that the blende from the Bawdwin mines of Burma can serve as raw material. In any scheme for the manufacture of the pigment there are two directions in which attention ought to be focussed: (1) The conditions of treatment of the precipitate so as to develop proper pigmentary properties. (2) The elimination of impurities for obtaining a light resistant material. Only then is standard Lithopone of commercial value possible.

Two other important whites are white lead and zinc oxide, the invariable constituents of exterior oil paints and enamels respectively. The raw material for their manufacture is again the mixed sulphide from Burma. White lead of satisfactory quality is being produced in the country from Burma lead by the precipitation process. There is no reason why production should not be increased. The outlook with regard to zinc oxide production by the direct process is discouraging. But the American method of preparation of cheap compositions containing basic lead sulphate and zinc oxide, straight from the mixed ore is deserving of careful consideration by the Indian Industry.

The greatest achievement in the line of white pigments has been the introduction of a white derived from Titanium. Almost a Laboratory curiosity some years back, to-day it is a bulk commodity with an annual output of 1,50,000 tons. Its strength, obliterating power, non-poisonous nature, complete inertness and above all versatility opened up entirely new fields for the industry. The raw material used is Ilmenite sand, of which the home reserves are estimated at 75 million tons. The export of the ore from Travancore began in 1922 and has expanded continuously. Attempts have yet to be made for utilising the same in the country. The process is well known. Present research must seek to eliminate impurities and elucidate the precise conditions under which the oxide develops proper pigmentary value. What is further needed is enterprise for starting a large modern plant with careful scientific control and intelligent commercial direction.

Passing on to the coloured pigments the most common are the earth colours. Red oxides of iron and yellow ochres of very good quality are available in the country and their production is continually on the increase. Umber and Sienna, which are of greater value are, however, surprisingly absent. These natural colours have the great advantage of being cheap. But they are available in very few shades. They lack brilliancy, uniformity and high staining power.

The artificial oxides of iron answer the demands of the industry for a better class of pigment materials. Their manufacture could be controlled and standardised. They are in addition much cleaner, possess better body and a finer texture. The synthetic oxides could further be used to tint natural ochres of low grade to improve their staining power. Their methods of preparation fall under two heads, the dry and the precipitation methods. In the dry method, ferruginous materials are calcined under controlled conditions. Precipitated hydroxide of iron is subject to treatments in the second method. Their manufacture merits enquiry. Although an attempt has been made in this direction, a great deal of work has to be done before standard shades of suitable quality are turned out.

The average consumer in most cases is content to buy dry colours and prepare the paint himself. The importance of their manufacture is thus easily realised. Many of the important pigments like Red lead, Prussianblue, Lead chromes, Brunswick green, and chromic oxide green whose manufactures have been attempted, call for increased production and great improvement in quality. The production of blacks of good staining power; cheap alkali resistant blues of the ultramarine type; organic Lake colours fast to light from coal tar dyes—these are lines which if pursued would confer great benefit on the industry.

The finished products of the Paint trade fall under one or other of the following classes: water paints; oil paints; lacquers, varnishes and varnish paints; Anti-corrosion paints; Enamels; Pyroxylin compositions and Synthetic finishes. From the point of view of the Indian Industry it may be useful to consider them under the following heads: (1) Those in which considerable progress has already been made. (2) Those which offer great scope for trial, experimentation and improvement. (3) Those in which there is little prospect of immediate commercial success.

Water paints, oil paints, lacquers, Spirit varnishes and Anti-corrosive compositions come under the first category. Among decorative paints, those thinned with water are the cheapest and deservedly popular. An ideal water paint should not rub off from the surface and withstand washing by water. It must be in dry powder form and miscible with cold water. Most of the commercial brands fall far short of this standard. It has been shown by the author[1] that highly satisfactory products could be obtained by using as binding medium a vegetable protein,—carbohydrate complex and as base, better grades of colloidal

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[1] Ind. Pat. No. 20192, 1933.

clays with comparatively small proportions of Lithopone. These have the further advantage of being perfectly non-smelling during application or drying.

Emulsion Paints have always been of interest to the industry. Opinion is undivided as regards their future. The most practicable among them for the Indian market would be the Linseed oil—water-type. The author has succeeded in preparing compositions, suitable for application to wood or metal. These contain boiled or treated Linseed oil medium to the extent of 50% of the water vehicle. The base is Lithopone reduced with Barytes. Zinc oxide is added in some cases in small proportions. The size is a protein—modified cellulose mixture, prepared straight away from indigenous vegetable sources by simple methods.[2] The paint is produced as a stiff paste and softens readily when thinned with water before application. It flows nicely under the brush, covers well and is waterproof.

Such a paint could be obtained cheap and is of importance therefore under present economic conditions. The thinning medium is entirely water. No special costly emulsifier is employed. The size which is formed as a precipitate during preparation is used wet and serves to emulsify the oil and bind the pigments to the surface. Colours, many of which result in wet methods, could be incorporated as such and their drying costs obviated. It must be admitted that as regards weathering properties, a regular oil paint scores over the emulsion one. But it is not always that a complete destruction of the paint film is awaited, for repainting to be undertaken. More often there is a liking for change of colour. The ease of making and brushing of the emulsion paint renders possible to finish the painting with greater despatch and thus save in time and labour. It is not unlikely that it is more economical than the ordinary type, when durability per unit of price is taken into account. Further it dries quick and can be applied even in unfavourable weather. It is non-smelling while applying and leaves little lingering odour. These are highly desirable features particularly in house painting where a minimum of inconvenience to the occupants would be desired. The emulsion paint imparts a pleasing and restful eggshell effect, which in recent times has preference over a bright gloss. The surface however lends itself to further varnishing if desired.

Oil paints have made considerable headway in the country, as their formulation is devoid of much technique. They are produced by grinding together a pigment or mixture of pigments with oil, adding driers and thinning suitably. A great impetus to manufacture has however been afforded by improvements of plant technique. The result has been the introduction of ready-to-use paints of great convenience to the consumer. To-day the demand is for a quick-drying paint and this can be met by many an expensive synthetic finish. Present efforts could therefore be largely directed towards methods of treatment of Linseed oil so as to endow it with quick-setting properties without sacrifice of durability, brushing and storage qualities.

The use of shellac in the industry has received considerable attention for some time. It is a subject in itself, of great importance as lac is a virtual Indian monopoly. Among the products, that in general use is French polish, a varnish for woodwork made up from shellac, a soft resin and methylated spirits. Spirit varnishes yield, with aniline dyes in alcoholic solution, coloured lacquers useful for wood, metal or leather goods. These varnishes could also be incorporated with pigments for production of glossy paints possessing quick drying properties. By far the largest consumption, however, is as Insulation varnish for application in the electrical industry.

In many of these directions lac is threatened by competition from synthetic substitutes. Being laboratory products, their supplies are regular, prices dependable, trade organised and above all, quality uniform. Their properties, largely under scientific control, could be varied to adapt them for purposes on hand. Research measures that have been adopted to resuscitate the Indian trade in lac are directed towards better production and improved manufacture. The aspect of improvement of the quality and quantity of lac has been carried out at the Research Institute at Namkum. More recently the technical side has come in for consideration. It embraces an extended study of the physico-chemical properties of lac, which largely determine its value; devising of methods to rectify the weaknesses of lac so as to meet the needs of the consuming industries; and finally,

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[2] Ind. Pat. No. 20143, 1933.

exploring of new avenues for its applications. The close association of the industries, concerned in these studies, is a factor of no mean significance. The results will be watched with interest even by those who wish to preserve the field for demand of the material within the country.

Special paints for protection of iron work are made in large quantities and used. Mention might be made of oxide of iron and red lead paints and the more recent ones containing a metallic pigment like aluminium. Considerable attention has been devoted to the production of bituminous compositions for which sometimes extravagant claims are made. Many of them are compounded from Asphaltum, one or other of the artificial pitches and Linseed oil treated with Litharge, red-lead and a varnish-making gum. The thinner is usually turpentine.

High grade oleo-resin varnishes which would suit actual conditions, are still products of future manufacture. Progress in the line has been inconsiderable as their production is an art in which empiricism is the sole dictator. A varnish is obtained by cooking a drying oil like Linseed, with a varnish-making gum, adding proper driers and thinning. Experience alone can guide in the choice of ingredients and their manipulation, factors which decide the quality of the final product. The raw materials except the resin are found in the country. Success must depend therefore on patient formulations and practical trials.

Specially compounded varnishes serve as media for Enamels. These dry quick and give hard and durable surfaces with permanent gloss. The colours and pigments therein are in a much finer state of division than in ordinary Paints. An enamel which does not thicken and is satisfactory in several respects, can only result from a proper choice of the pigments for incorporation into the media whose preparation is as important. The field is open and offers ample recompense for adequate experimentation.

Synthetic and Pyroxylin finishes are infants in the trade. Though their production in Western countries rivals that of other materials, they are only of subordinate importance in the Indian industry. The Synthetic finishes are based on the manufacture of artificial resins, which could be dissolved in suitable solvents to yield media for paint varnish or enamel. What is aimed here is improvement over the natural products, with regard to adhesion, durability and gloss retention.

Pyroxylin finishes contain as media, low viscosity solutions of cellulose nitrate in various organic solvents together with a plasticiser like castor oil or triphenyl phosphate to render the film flexible. They could be coloured to form lacquers, combined with resins to produce varnishes and incorporated with pigments to give enamel paints.

A great drawback to the use of the above two modern finishes is their expense and as a consequence, only a very limited market could be found for them. The problem of the solvents for use—many new ones have been introduced—has yet to be successfully solved by the Indian industry. Further their production calls for special technical skill of a high order. Their manufacture in the country may not therefore be assured of a welcome for some time to come.

"Vernalizing" and Crop Yields.

MR. T. Lisenko, the Russian scientist, announced before the recent Conference of the Soviet Academy of Agricultural Sciences, the results obtained by *vernalizing* a new process for seed regeneration possessing great potentialities for increasing crop yields and insuring against crop failures. The method which is applicable to all self-pollinating plants is to take the pollen from 100 to 200 plants of the same variety, mixing it with a brush and then dropping the mixed pollen into the flowers after bending back the petal-scale with pincers. The seeds obtained are first moistened and then submitted to different degrees of heat before sowing. By this simple process it is possible to obtain plants better adopted to the region than their parents. *Vernalized* wheat matures 3 to 7 days earlier than untreated seed; the treated seed also sprouts earlier. 1,500,000 acres in the Kuibesheff (Samara) Province have been planted with *vernalized* wheat and 1,000,000 acres in the Ukraine Province. In the latter Province, 3,000 acres were planted with *vernalized* cotton seed and the results were, in all cases, satisfactory—the crops developed earlier and the yields were higher as compared with untreated seed.

Research Notes.

The Relation of the Splitting to the Field Strength in the Zeeman Effect of Some Mercury Lines.

THE successful production of high magnetic fields by Kapitza has given rise to new and interesting problems. One of these is the behaviour of the Zeeman pattern of spectral lines in these high fields. Kapitza and Skinner found that in the case of λ 4047 ($^3P_0 - {}^3S_1$) of mercury the separation between the Zeeman components increased more rapidly than the field. Now G. Dupouy and P. Jacquinot (*Comptes Rendus*, 1935, **201**, 543) have studied the behaviour of $\lambda\lambda$ 5461, 4358 and 4047 ($^3P_{2,1,0} - {}^3S_1$) in fields up to 50,000 gauss produced by the large Bellevue magnet. They found that the patterns of 5461 and 4358 were not of similar constitution at different fields. Thus the theoretical pattern of 4358 is $\frac{(1),\ 3,\ 4.}{2}$ The authors now find that the separation between $\pm 3/2$ is proportional to the field strength while that between ± 2 increases more rapidly than the field. Hence they conclude that the separation of the $^3P_1$ level is strictly proportional to the field while that of $^3P_2$ and $^3S_1$ is not. Another interesting point is that the ratio of the splitting of $^3P_2$ and $^3S_1$ is constant. The effect thus found is not connected with the Paschen-Back effect since the fine separation of the mercury triplets is very large. The influence of high order terms in the Larmor precession cannot be a possible explanation since the separation of $^3P_1$ is proportional to the field. The anomaly is thus unexplained.

T. S. S.

Observation of the Brownian Motion with the Unaided Eye.

THE observation of Brownian movement with the unaided eye has recently been considered in a number of papers. The phenomenon observed is a lively shimmering with colour variations seen when a concentrated sol of rosin or solution of gamboge placed between two glass plates is irradiated by strong light from a point source and observed by means of the light it scatters. The eye is to be focussed on the sol. There has been some controversy as to whether the phenomenon is really due to Brownian motion, but E. Kappler (*Physikal. Zeit.*, 1935, **36**, 643) now put forward some reasons for believing that what is seen is really the effect of Brownian motion. Considering two surface elements which are just seen separate by the eye, the brightness and colour of these vary as the concentration of the layer varies on account of the Brownian motion and the diffraction and interference phenomena due to the particles in these surface elements alter. This alteration of brightness and colour gives a sensation of irregular motion. That interference is the cause of the observed colour and light variation is seen from the fact that the sol must be irradiated by a point source while diffuse illumination makes the solution appear uniformly bright. The effect is not visible in or near the direction of the incident rays. The particles of gamboge have to be sufficiently near, that is, a fairly concentrated solution is necessary. When the solution is observed with a microscope with large aperture the ordinary Brownian motion of the particles is observed, the particles appearing dark on a bright background in direct light and as bright points on a dark background in scattered light. In scattered light we find an entirely different appearance when the aperture of the microscope is small. The several particles are no longer seen separate but the light coming from different layers shows a lively variation of colour and brightness. An explanation of these phenomena in terms of Abbé's theory of the image formation by non-self-luminous substances is given in the original paper.

T. S. S.

Use of Direct Current in the Measurement of Electrolytic Conductance.

BRONSTED AND NIELSEN (*Trans. Far. Soc.*, 1935, **31**, 1478) have pointed out the advantages of using direct current in the determination of conductivities of solutions. A simple apparatus is described involving the use of two lightly platinised electrodes which are rendered non-polarisable by bubbling hydrogen through them. This is found to be particularly suitable for the measurement of conductivities of acids and bases. The method described should be of immense use in the measurement of high resistance systems, where the usual alternating current method is not so satisfactory.

M. P. V.

Electrometric Estimation of Traces of Chloride.

THE usual nephelometric procedure for the estimation of traces of chloride present as impurity in reagents is not very satisfactory, as the presence of salts considerably affects the measurements. Furman and Low (*J. Amer. Chem. Soc.*, 1935, **57**, 1585) have described an electrometric method involving the use of silver-silver chloride electrode. A concentration cell is constructed wherein liquid junction is eliminated, by making the solutions into which the two silver-silver chloride electrodes dip identical except that one side of the cell has the chloride of unknown concentration x, and the other side $x + a$, when a is a known weight of chloride added to the solution under test. Traces of chloride of as low a concentration as ·00035 gr. of Cl^- per litre have been measured accurately by this method. This is of quite general applicability, and should be useful for other reversible electrode systems.

M. P. V.

Oil Formation in the Groundnut.

THE progress of oil formation in the groundnut has formed the subject of a study by J. S. Patel and C. R. Seshadri (*The Indian Journal of Agricultural Science*, Vol. V, Part II), who conclude that as the groundnut develops, the percentage of oil gradually increases except in the early stages immediately following blooming and the period just preceding maturity. There is throughout the development of the seed a gradual and uniform gain in oil content and reduction in the free fatty acid content. The harvest of the groundnuts even one week before the kernels are fully mature increases the quantity of free fatty acid and reduces the oil content by about five per cent. The high free fatty acid content in the groundnut reaching England from the Coromandel Coast ports and from Calicut which goes up as high as 11% and therefore reduces its quality and price very considerably, is surmised to be partly due to the practice of harvesting the groundnuts before they are fully mature. It is significant that Marmagoa and Bombay shipments which include the crop from the Mysore State are strikingly low in their fatty acid content being only about 2·5 per cent. at the most.

Photo-Oxidation of Sulphur.

EXPERIMENTS by Fazal-ud-Din (*The Indian Journal of Agricultural Science*, Vol. V, Part II) establish that elemental sulphur undergoes oxidation by mere exposure to light which thus becomes an additional agency to bacterial and chemical oxidation. The photo-oxidation is also found to be greater in the presence of certain catalysts such as zinc oxide, animal charcoal, and soil, the action due to zinc oxide being however negligible when compared with the other two. In these latter, the oxidation proceeded even further when light was excluded. In an alkaline medium the oxidation was slightly higher. In soils rendered sterile as regards sulphur oxidising bacteria, the photo-oxidation was very much slower than in soil not rendered sterile. It would be interesting to study the extent of the solubility of the phosphate in animal charcoal or bonemeal mixed with sulphur and treated in the most favourable manner for photo- and bacterial-oxidation of the sulphur.

Oxidation of Fats in Animal Tissues.

IN the course of two important papers appearing in the *Biochemical Journal* (1935, **29**, 2143–80), Jowett and Quastel have made a critical study of fat metabolism by employing an *in vitro* method, which takes advantage of the previous observation (Quastel and Wheatley, *Biochem. J.*, 1933, **27**, 1753) that fatty acids are oxidised at considerable rate by slices of liver, giving as one of their oxidation products acetoacetic acid as in the body; the acetoacetic acid is estimated by the manometric method of Warburg. A study of the kinetics of the oxidation of butyric, crotonic, β-hydroxy butyric acids by the liver of the Guinea pig, has shown that the rates of oxidation are in the order cited, being highest for butyric. The variation in the rate of oxidation coupled with the observations that propionate and cinnamate while inhibiting the oxidation of butyric and crotonic acids, possess no effect on the oxidation of β-hydroxy butyric acid, rules out the view previously held that the mechanism of oxidation of the three acids are interrelated. The view that β-hydroxy butyric acid is an intermediate product is also untenable; in fact the indications are that this acid is produced from acetoacetic acid. It is however probable that crotonate passes through

butyrate as an intermediary. It is even more probable that the process of oxidation to acetoacetate takes place after adsorption on the surface of one and the same enzyme which effects the complete process with both butyrate and crotonate.

In the second part, the authors have extended the studies to the oxidation of normal saturated fatty acids containing from 2 to 10 carbon atoms. In the first place, it has been shown that there is a relation between the increase in acetoacetic acid production and the increase in respiration brought about by the fatty acids, a relation which is characteristic for each acid. There is also a characteristic difference between the behaviour of acids with even and odd number of carbon atoms, the latter being more completely oxidised in the liver. Acetoacetic acid is probably the only β-ketoacid produced in significant quantities by the oxidation of fatty acids. The β-oxidation theory of Knoop is inadequate to explain all the observations quantitatively. The observation that benzoate strongly inhibits the production of ketonic bodies from butyrate, while the inhibition is less with higher fatty acids, suggests that butyric acid is not an intermediary in the breakdown of higer fatty acids as demanded by the theory of Knoop. The authors propose a "multiple alternate oxidation" theory according to which the fatty acids undergo, at a common enzyme, an oxidation throughout the fatty chain, alternate carbon atoms being affected. The oxidised product then breaks down, and the ultimate production of acetoacetic acid and other acid products. The theory is somewhat speculative, and further developments are keenly awaited.

Iron Gallate Inks—Liquid and Powder.

ZIMMERMAN (*Journal of Research of the National Bureau of Standards*, 1935, **15**, 35) describes experiments carried out with a view to prepare inks and ink powders which would not only satisfy the requirements of the U. S. Government Standard writing ink but at the same time be less corrosive on steel-pens.

The effect of gallic and tannic acids on the stability of inks was studied quantitatively by noting the period which elapsed before any sediment was observed.

The substitution of ferric sulphate for the ferrous sulphate in the preparation of ink was found to result in increased corrosive action on pens, but it was also found experimentally that addition of oxalic acid (about 3g/L) to ink so prepared, not only reduced its corrosive action considerbly, but also increased its stability. Oxalic acid, however, accelerates deterioration of paper, and so such ink is unsuitable for making permanent records.

Three '*formulas*' are suggested in a tabular form for the preparation of ink, either liquid or powder.

K. R. K.

Separation of Petroleum Hydrocarbons with Silica Gel.

IN a paper published in the *Journal of Research of the National Bureau of Standards* (1935, **15**, 51), Mair and White have presented the results obtained in a study of the efficiency of silica gel as an adsorbent of some types of petroleum hydrocarbons with a view to its application to the important problem of the separation, identification and determination of the constituents of petroleum.

Two grades of silica gel were employed, one being 40–200 mesh, and the other 200 mesh and finer. The silica gel was kept at the lower end of a glass tube and served as a bed through which the hydrocarbon mixture filtered at a predetermined rate.

Adsorption experiments with the following systems were performed: (1) mixtures of an aromatic and a naphthene or a paraffin hydrocarbon, (2) mixtures of a naphthane and a paraffin hydrocarbon, (3) petroleum distillate boiling between 140 and 145°·5 C.

The results of these experiments show (*a*) that there was a complete separation of the aromatic and olefin hydrocarbons from paraffin and naphthene hydrocarbons, (*b*) that the gel showed a tendency to adsorb the naphthenes in preference to the paraffins, (*c*) that there was a slight separation of normal paraffin hydrocarbons, the paraffin of low molecular weight being adsorbed in preference to that of high molecular weight.

It was also established that in none of the experiments carried out did the silica gel crack or otherwise attack any of the hydrocarbons employed.

A simple and efficient laboratory method (98 per cent. recovery) employing silica gel is suggested for the complete removal of aromatic from naphthene or paraffin hydrocarbons.

K. R. K.

Oogenesis of Acentrogobius Neilli.

M. K. SUBRAMANIAM AND R. GOPALA AIYAR have published the results of their investigations on the vitellogenetic activity in the ovum of Acentrogobius Neilli (*J. Roy. Micr. Soc.*, September 1935, **55**, Pt. 3) in which they record that the Golgi apparatus which makes its appearance in the young oocyte in the form of a single dense mass in the neighbourhood of the nucleus. Later the mass is seen to break up into a number of minute grains which migrate towards the periphery. Fatty yolk is formed from them. The mitochondria which are at first in the form of a circumnuclear ring later become dispersed. The authors are definitely of opinion that they do not take any part in deutoplasmogenesis. A nucleolar origin of fat is described. Even in the earliest stages the nucleoli are multiple and as growth proceeds they move towards the periphery of the nucleus. The authors have put forward the novel suggestion that even within the nuclear membrane the nucleoli become lipoid and while there is no evidence of their migration into the cytoplasm, presence of fat globules outside the nuclear membrane adjacent to the nucleoli which have now taken up a perinuclear position has been adduced as evidence for the nucleolar origin of fat.

A Hitherto Undescribed Piroplasm of Goats (*Piroplasma taylori*).

EARLIEST record of piroplasma in sheep was made in Roumania by Babes in 1892. Since then various workers have recorded the presence of piroplasma in the blood of sheep and goats. In India only two records are available—one from Muktesar among goats and the other from Mysore among sheep. Sarwar (*Indian J. Vet. Sci. and Anim. Husb.*, 1935, **5**, 171–176) has observed a piroplasm in goats which does not agree in any way with the description of the hitherto recorded species. Its morphological features are suggestive of its being a new one. The parasite was obtained during post-mortem examination on a goat.

The infected red blood corpuscles are distinctly enlarged in size proportionately with the number of parasites occupying them. The parasite divides into two or multiples of two at the same time. From 2 to 16 elements have been noticed in the red blood cells.

The author proposes the name "Piroplasma taylori" to the new species of piroplasm.

S. D. A.

Bovine Surra in India.

Indian cattle and buffaloes generally are found to possess a much higher degree of resistance to Surra than equines and they often harbour the parasites in their blood without evincing any evidence of disease. But some outbreaks have been noted in the Punjab and Hyderabad State where the disease has proved fatal to the animals.

Krishna Iyer and Sarwar (*Indian J. Vet. Sci. and Anim. Husb.*, 1935, **5**, 158–170) refer to an outbreak at the Imperial Cattle Farm, Karnal, where 12 animals were affected and 4 died out of 176 animals on the farm. The disease was observed to be more severe in bullocks and young male animals, whereas in cows, the disease appeared in a milder form, and none of the affected cows died.

Various drugs such as Atoxyl and Arsenic, Chiratta, Neem leaves, "Bayer 205", Tartar emetic and Naganol have been tried by various workers. The authors claim successful results by treating the affected with 10 to 30 c.c. of a 10 per cent. solution of "Bayer 205" intravenously.

The authors have discussed the transmission of Surra by invertebrate vectors. The abnormal contents of two Bdellolarynx flies were found to contain trypanasomes immediately after they had fed on infected animals.

T. evansi is the specific protozoa that caused Surra in this outbreak.

S. D. A.

Ciliates from Indian Mammals.

A NUMBER of papers on Ciliates Protozoa belonging to the family *Ophryoscolecidæ* have been published recently. Prof. C. A. Kofoid visited India as far back as 1916, and made a large series of preparations of Ciliates from *Bos indicus*, *Bos gaurus* and *Elephas indicus*. Those from *Bos indicus* have been exhaustively studied by Kofoid and MacLennan in a series of monographs (1930–33) which have been already noticed in this Journal *Curr. Sci.*, 1935, **4**, 13-16). Kofoid and Christenson (*Univ. Calif. Public. Zool.*, 1934, **39**) have described 25 species belonging to 8 genera from the stomach of the gaur. Of these, 11 species are the same as already

described from the Indian ox, and 9 species identical with those already recorded from domestic cattle, etc., in other parts of the world. Five species, *viz.*, *Entodinium contractum*, *E. curtum*, *Metadinium rotundatum*, *Ostracodinium mysorei*, and *O. gauri* are new to science. These Ciliates from the wild relict member of the ox tribe show no primitive characteristics, being as complex in their evolutionary tendencies as those from other domesticated ruminants. The two species described by Kofoid (*Proc. Nat. Acad. Sci., Washington*, 1935, **21**) from the cæcum and colon of the elephant are very remarkable indeed. *Polydinium mysoreum* and *Elephantophilus zeta* not only belong to new genera, but have to be placed in a new subfamily. In other genera of *Ophryoscolecidæ*, known so far, there is either the adoral zone of membranelles only present, or a second dorsal zone in addition. The members of the new sub-family, *Polydiniidæ*, are characterised by the presence of numerous accessory membranelle zones extending over the considerably elongated body. These zones instead of being dorsal are divided bilaterally in two groups, and thus a secondary bilateral symmetry is superposed upon the primitive spiral one.

M. Das-Gupta from the Department of Zoology, Calcutta University, has published an interesting record of Protozoa from the rumen of the goat, *Capra hircus* (*Arch. Protistenk., Jena*, 1935, **Bd. 85**). Besides 1 rhizopod and 6 flagellates, no less than 36 species belonging to 11 genera are recorded with brief notes. Of these latter, four are described as new species of *Entodinium* and 13 species belonging to several genera are believed by the author to be new records from the goat. What a wealth of material is at hand in such a common animal as the goat!

The Ciliates from the horse, sheep, and camel have not yet been studied in India so far.

B. L. B.

The Y-Granules in Insects.

SINCE the discovery in Saccocirrus of a group of granules allied microchemically to yolk, attempts have been made to find them in other animals and J. A. Muliyil's work, on a number of insects (*J. Roy. Micr. Soc.*, September 1935, **55**, Pt. 3) has revealed their existence. Most cases can be demonstrated by the employment of neutral red though this is by no means the most specific method. In a few cases, a single homogeneous body later breaks up to give rise to the characteristic granules. Evidently their function is not known and they are eventually cast out during spermateleosis.

Malpighian Tubules in Melanoplus.

R. R. STUART describes the structure of the malpighian tubules in the grasshopper Melanoplus (*J. Morph.*, 1935, **Bd. 58,** No. 1, p 173). There are about 192–312 malpighian tubules, collected into twelve bundles. Each bundle opens into an excretory ampulla. Each tubule is composed of large polygonal cells. The ampulla consists of an inner mass of unchitinised epithelium and a layer of chitinised cells. These two are separated by a narrow irregular lumen. The epithelium of the cephalic intestine is thrown into 12 long folds.

The Mineralogical Classification of Igneous Rocks: A Comparison of Recent Proposals.

IT is well known that the want of a standard method of classification of igneous rocks has rendered the task of many petrographers difficult, more so in recent times where each author favours his own type of classification. In comparing the mineralogical with other types of classification S. J. Shand (*Journal of Geology*, **43,** No. 6) has put forward a strong plea for evolving one common type of classification. Shortly reviewing the works of Iddings, Winchell, Holmes, Niggli and Grout, Shand has shown that there is a general tendency to accept two instead of three textural divisions as a basis for classification. With the increasing recognition of colour index, and the use of actual instead of calculated felspar, it is possible to develop a fairly comprehensive classification; and if leading petrographers come to an understanding on these points, it will be a great relief to many workers in their every-day work, leaving the other types of classification for specialists desiring to institute broad comparisons for purposes of regional geology.

The Fifth Congress of the International Society of Sugarcane Technologists.

The Meetings and Excursions.

THE above Congress met at Brisbane in Australia from the 27th August to 3rd September, 1935—the meetings being divided into various sections such as Agriculture, Breeding and Sugarcane Varieties, Methods of Field Experimentation, Sugarcane diseases and various aspects of the factory. The Congress was well represented, the members who answered the roll call hailing from all the important sugarcane countries of the world—Hawaii, Lousiana, Porto Rico, West Indies, Cuba, United States of America, Peru, South Africa, British India, Java and others.

The State Government of Queensland, the Commonwealth Government of Australia and the various sugar interests in Australia, all combined to make the delegates feel quite at home in that interesting country. At the end of the Congress meetings at Brisbane a special train took the delegates into the various plantations and sugar factories. This tour which lasted almost a fortnight was very interesting as bringing the delegates into close contact with a Sugar Industry which has certain very interesting features to the visitor from abroad.

THE SWEETEST CANES IN THE WORLD.

Australia is adjacent to New Guinea which is believed to have been the home of at least one race of the sugarcanes in cultivation and the dominant cane in cultivation in Australia to-day is Badila—one of the original types found in New Guinea. The breeding of new canes from seed has been in progress in Australia for some time and has resulted in types suited to special conditions; but in the best cane lands Badila still holds its own. This cane has been tried in various parts of India, but it has shown its usefulness only in one locality in South India—in the factory plantations at Nellikuppam.

Australia also grows the sweetest cane in the world and the sugar recoveries are higher than in most other countries due chiefly to the quality of raw material. The general trend of opinion at the Congress indicated the set of climatic conditions in Australia as the chief factor contributing to this superior quality. It was found that the same variety showed better juice quality in Australia than elsewhere. The Coimbatore cane—Co.290—which is proving useful in Australia chiefly on account of its marked resistance to the diseases common in Australia, shows better juice quality in Australia than in India.

CROP GROWN WITH 100% WHITE LABOUR.

But perhaps the greatest interest of the Australian industry to the visiting delegates lay in its being run on a "White Australia" policy and the adjustments arising out of it. At present only white labour is employed in the sugar factories and plantations. The standard of living in Australia is said to be higher than in most other countries and the white labourer in the sugar plantations in Australia is entitled by law to receive as wages 16 shillings (Australian) per day, which is almost equivalent to about half a month's wage in Java and India.

This has led to a marked development in labour-saving machinery and this was prominently brought to the notice of the delegates during the itinerary after the Congress meetings. From the time of planting—which itself is done by machinery—right to the harvest the machine does all the field operations including weeding after cultivation, application of fertilizers, etc. As to harvesting machinery, though one was demonstrated in one of the largest plantations, the mechanization of this part of the operation has not yet been a complete success.

A WELL-PLANNED INDUSTRY.

The whole industry in Australia is run on a thoroughly planned basis, which naturally involves control at various stages either by Government or Pseudo-official bodies like the Sugarcane Prices Board set up by Statute. The area from which the factory is to derive its supplies, the wages to be paid to the labourer, the working hours for labour —including a factory holiday on Sunday— the price to be paid to the cane and the rate at which sugar is to be sold in the country, are all fixed.

AUSTRALIAN SUGAR WELL PROTECTED.

It was certainly most interesting to learn that whereas the price of sugar per lb. in Australia was 4*d*., the same Australian sugar sold in the London markets fetched only about 1½*d*. Though Australia loses about £ 6 to 8 (Australian) on every ton of sugar exported, ample justification for maintaining the industry is found (i) in finding employment for the Australian white population and that too at a high standard of

living, (ii) in populating the rather vulnerable North Queensland, and (iii) in supplying the country with home-grown sugar.

The profits of the industry appeared to be better distributed than in most other countries and one marked feature was the fair number of factories owned by the growers themselves on a co-operative basis.

DIFFERENT STRAINS OF THE SAME DISEASE.

On the scientific side, discussions at the Congress brought out many points of interest. The papers presented indicated almost unmistakably the possible presence of different biological strains or pathogenic types of one and the same disease. This has an important bearing on the transport of new canes from one place to another and on the methods of disease-resistance trials.

USE OF *Saccharum Robustum* AS PARENT.

Saccharum officinarum when crossed with *Saccharum spontaneum* (male parent) doubles its chromosome on the mother side. No such doubling takes place when *S. officinarum* is crossed with *S. robustum*. This opens up a new line of work in Sugarcane Breeding so far at least as the tropical sugar world is concerned. Sugarcane breeding has gained greatly by the use of *S. spontaneum* as one of the parents. The use of *S. robustum* has not yet been exploited and there are indications from Hawaii that for Hawaii, at any rate, the use of *S. robustum* is likely to be useful. The delegates—including Dr. Brandes, the discoverer of *S. robustum*—saw in one of the Breeding Stations in Australia certain promising seedlings obtained from the mating with *S. robustum*.

MANY DISEASES KEPT UNDER FULL CONTROL

Similar interesting facts emerged from the discussions in the other Sections as well. But one fact which impressed the Congress as a whole was the very successful manner in which the various cane diseases had been controlled in Australia by suitable organization of control measures and growing resistant types. So efficiently has this been done that, though in the first circular it was mentioned that pathologists would have an opportunity to see many diseases, in the actual visits to the plantations it was difficult to get good specimens of the same.

The Congress was fortunate in having the presence of such a distinguished sugar-man as Dr. C. A. Browne, who was specially honoured by the Congress at its full session. The next Congress is to be in Louisiana in 1938 under the General Chairmanship of Dr. E. W. Brandes, the well-known head of the Bureau of Plant Introductions, United States of America.

The Shape and Size of the Earth.*

THE fundamental problem of geodesy is the accurate determination of the form of the Earth or the deviations of the actual geoid from the international ellipsoid and also study the dynamic causes that bring about a change in this form, the guiding principle being the principle of isostasy.

The problem of the determination of the form of the earth resolves into the following :—

(1) Observation of the mean levels of the sea ; therefore a study of the tides in the oceans at different places.

(2) Observation of the surface inequalities. This involves levellings to determine the height, etc., by means of spirit levels and telescopes.

(3) Determination of distances on the earth in different directions. This is done by a system of triangulations by means of chains of standard lengths made of invar to determine the distance of two stations along what is called a straight *base line*. A precision theodolite enables the position of a third station to be observed from the first two by noting from each the angular separation of the two other stations. This is extended through a large number of stations to those hundreds and thousands of miles distant. By assuming a mean form of the geoid the longitude and latitude (geophysical) could be measured with respect to a standard station, chosen centrally.

(4) Determination of the astronomical latitude by observation of the azimuths of two stars one on either side of the zenith, or vertical or plumb line, at the place of observation by means of telescopes.

(5) Determination of the astronomical longitude by observing the local time by the transit of stars over the meridian and simultaneously getting by means of accurately adjusted chronometers or time signals times

* The Survey of India, Geodetic Department, 1934.

from some place of reference whose longitude is assumed.

(6) Comparison of 4 and 5 with 3 gives an expression of the deviation of the plumb line, or of the direction of gravity from the vertical (the perpendicular to the international spheroid or whatever general geoid that fits best). This gives gravity level surfaces.

(7) The curvature of the plumb line measured by the torsion balance of Baron Ötvos. One type of this balance in which two equal weights are attached to the ends of a beam suspended at the middle with a quartz fibre gives the gradient of the gravity deflection along two directions. A second type in which one weight is above and the other equally below the beam enables the gradient to be measured in magnitude as well.

(8) Determination of the absolute intensity of gravitation at different places by means of pendulums.

(9) Determination of the intensity of gravity on sea, by means of a barometer to be read correct to 0·01 mm. and determination of boiling point of pure water to an accuracy of 0·001° C., in that with change of gravitational intensity alone the pressure read off remains the same, the boiling point however indicates the change.

(10) Purely astronomical measurements of the precession of the equinoxes. They enable the form of the earth to be calculated. If the earth were perfectly round, there would be no precession.

The determination of the accurate form is of utmost importance in the location of mineral resources such as ore, coal, oil, etc., even when hidden deep in the crust, because these minerals are pretty sharply distinguished from the rest of the crust by their density so that measurement of plumb line deflection gives the wanted clue. Almost every government has established departments of its own for such measurements. The Geodetic Branch of the Survey of India, Head Office Dehra Dun, is in charge of these measurements in India. The Survey of India is an old institution. The Great Trigonometrical Survey was started in 1800. From 1922 the annual reports are published in three separate volumes of octave size, *viz.*, (1) General Report which is confined to reporting the Survey operations of the ordinary field parties and detachments with only brief abstracts of Geodetic operations, and Map Publication and Office Work. Published annually. (2) The Map Publication and Office Work Report which contains all the Index Maps showing the progress of Map Publications on all scales, with reports on publications and issue. Published annually beginning with year 1924, price Rs. 3. (3) Geodetic Report which includes full details of all scientific work of the Geodetic Branch, Survey of India. From 1933 inclusive, the General and Map Publication and Office Work Reports have been confined into one report under the title of General Reports at Rs. 1–8–0.

Triangulation, levelling, gravity, deviation of the vertical and predictions of tides have been the main features of the Geodetic Reports of every year. Preparation for the international longitude project began in 1925–26 and was receiving the attention of the Department in years 1926–27 and 1934, magnetic measurements were made in 1925-26. In 1930–31, a Magnetic Survey was included. In the 1934 report (the latest) Chapter I, devoted to Triangulation and Base measurements, are given results of measurements of three base lines, one in Baluchistan, second in Poona and the third in Assam and the order of accuracy discussed (1 in about 600,000), the best hours for observation of the horizontal angles found to be either morning or evening. Levelling parties worked mostly in Burma and Northern Shan States. Late in the year three double detachments and eight single detachments were formed for levelling the Bihar Earthquake (Jan. 15, 1934) area. Bench marks showed shrinkages up to $4\frac{1}{2}$ feet and only four cases of elevations were observed of which the largest is 0·029 feet. The largest sinkages occurred in structures which had presumably sunk into the ground, and the embedded bench marks generally show smaller change although one case of 2·7 feet was observed.

Chapter III gives the results of pendulum experiments for the intensity of gravitational attraction in Ceylon, and in the Maldive and Laccadive islands. Gravity results of Ceylon show a satisfactory agreement with the geology. They suggest that the tilted syncline (folding in ellipsoidal, paraboloidal surfaces with same sign for the principal curvatures) of the island is unsymmetrical as it is distorted in the region of the Adam's Peak. In the Maldives evidence supports the theory that those coral islands are formed by gradual subsidence of the ocean bed due

to isostatic adjustment. Work at Minicoy leads to the interesting conclusion that the Laccadive islands are tectonically different from the Maldive islands.

Two detachments were employed on tracing sections of the geoid by means of stations at close intervals by observing both components of the deviation of the plumb line. One worked from Assam–Burma frontier through Bengal to Bihar. In 1934–35 it is expected to push this up to Agra and to observe in Sindh and Baluchistan. It is expected that by 1935–36 the whole section from Persia to Indo-China would be completed. The second detachment observed latitude only between Cape Comorin and Hyderabad (Deccan). The observations of the Siamese Survey have been made use of along with those of the Indian and the geoid calculated. The radius of curvature of the east-to-west section 2,500 miles long is 700 feet greater than that of the international spheroid, while the curvature of a 2,000 miles north-to-south section 1,500 feet less than that of the international spheroid. It is suggested that the geoid of South Siam is 100 feet higher than any geoid that fits in with those two arcs and that therefore South Siam shows some departure from isostatic equilibrium. This might lead to some earthquake in the near future.

In Chapter VIII on research notes, conversion maps are given showing the heights of the International Spheroid over the Everest Spheroid used by the Geodetic Survey, as well as over that of its spheroid II used since 1928. The short Chapter VI gives the value of longitude observed at Dehra Dun for the International project arranged by the Burma International de l' heure at Paris, working with four different instruments. Standardisation measurements are given in Chapter VII. Tide predictions from observations at 14 ports are given and the accuracy discussed.

B. DASANNACHARYA.

The Geology of Ceylon.*

THE island of Ceylon constitutes largely a continuation of the main geological formations of Southern India. Like the adjacent mainland it consists of large masses of ancient crystalline schists and narrow fringes of some of the later sediments deposited along the coastal strips.

Mr. J. S. Coates has recently published an account of the geology of the island, based on the results of his traverses over the greater part of the country, supplemented by numerous scattered observations which he had been able to make while engaged as Government Mineralogist. According to him nine-tenths of the island is occupied by the Archean crystalline schists with only a few narrow belts of sediments along the coast. The sequence of rock formations as given by the author is as noted below :—

Post Tertiary,
Miocene,
Jurassic,
Archean.

The *Jurassic* rocks are described as forming an insignificant series occupying a small area of less than a square mile in extent. They are found exposed near Tabbawa, at a distance of about 80 miles N.N.E. of Colombo, and form a series comprising of conglomerate, grits and sandstones, shales and nodular limestones attaining an estimated thickness of about 2,000 feet. The sandstones and shales are unfossiliferous, but impressions of a number of plant relics have been found in a clay bed. Amongst them, many of the identified species seem to be of lower Oolite and Upper Liassic horizons and correspond to the plant fossils recorded from the Madras Coast.

The *Miocene* rocks form the entire peninsula of Jaffna and they are also seen as narrow fringes in the north-west coast, extending to a width of about 10 to 12 miles inland. This formation consists mainly of fossiliferous limestone succeeded by a series of sandy argillaceous beds and mottled sandstones. The fossils from the Jaffna limestone include several identifiable species of molluscs and foraminifers. The palæontological evidence leads to the conclusion that this series of rocks of the north-west Ceylon are identical with similar rocks at Quilon in Travancore, and are of an older age than those of Karikal on the Coromandel Coast of India.

Pleistocene and Recent.—These post-tertiary formations consist of various types of coastal deposits, including sandstones, coral

* "The Geology of Ceylon," J. S. Coates. *Ceylon Journal of Science*, 1935, **19**, Sec. B, Part 2.

deposits and blown sand, a detailed account of which is given by the author.

Archean.—The Archean formations of Ceylon like those of the Peninsular India show a great variety of groups which are described under the following names:—

(*a*) *Bintenne gneiss.*—This name is given to a series of complex banded granitic gneisses covering an extent of about 5,000 square miles of the island in its south-eastern part. The biotite gneisses of this complex are noted to show very variable strikes, but they seem to dip consistently, especially in the eastern Bintenne area, everywhere conformably under the "Khondalite" rocks, forming possibly the floor on which the great masses of the latter group were laid down. The gneisses of this group form a composite series without any perceptible clear lines of junctions to enable one to separately classify and map the individual components. The Bintenne gneiss recalls certain features characteristic of similar gneisses of other Archean terrains, but it differs from the Bengal gneiss of India in having no intercalated beds of limestone or dolomite and also in containing very few accessory minerals.

(*b*) *Khondalite series.*—An extensive series of schistose and gneissic rocks comprising quartzite or granular quartz rock as its principal member, fissile quartz schists, finely banded quartz-felspar gneisses with or without biotite and garnet, impure crystalline limestones and a variety of garnet sillimanite schist, form among themselves a distinct group separable from the other gneisses of the island. They are confined almost to the central part of the island, covering an area of about 5,000 square miles.

They have a general resemblance in appearance and character to the great masses of the garnet-sillimanite-graphite schists or the "Khondalites" of the Kalahandi State in the north-east part of the Peninsular India. In Ceylon, varieties corresponding to the typical "Khondalites" of Dr. Walker, are rather rare, and many of the types differ from them generally in containing felspar and in not having graphite. The associated crystalline limestones or marbles, especially the darker varieties, contain abundant silicates like olivine, dark pyroxene, tremolite and pale phlogopite. Clinohumite is also found at certain places as a conspicuous constituent of these limestones. Pyrite, graphite, magnetite and spinel are some of the non-silicate minerals usually present.

The series with its intercalated bands of Charnockite is estimated to have a total thickness of some 30,000 to 40,000 feet. The rocks of this group, like the Khondalites of Peninsular India, are believed to have originated from the metamorphism of a series of sediments consisting of limestones, shales, sandstones and arkoses.

(*c*) *Kadugannawa gneisses.*—Bounding the western edge of the "Khondalite Series" in the central part of the island, is another series of rocks which outcrop as a thick lens of about 30 miles in length north and south and 8 miles across the thickest part, gradually tapering away at both ends. The types forming this complex are dense, black, glittering hornblendic rocks with more or less biotite and felspars, and comprise of banded, massive and schistose varieties. Some of the narrow bands are stated to contain mainly of pyroxene, while calcite seems to be always present. Attention is drawn to the close resemblance of these Kadugannawa gneisses to the calc gneisses of Fermor. The descriptions of these types as given, seem to fit in also with the types described as secondary pyroxene rocks or Tarurites from the Mysore State. The gneisses are regarded as metamorphosed calcareous sediments of probably the same age as the Khondalite Series.

(*d*) *Charnockites.*—The series of granulitic hypersthene rocks, comparable to the well-known "Charnockites" of Southern India are found widely distributed in Ceylon. They reach their greatest development in the south-west quarter of the island where they seem to be continuous over an area of about 4,000 sq. miles. They are also found as numerous thick sills between the schists of the Khondalite Series. Isolated exposures are found in other gneissic areas as well. Acid, intermediate, basic and ultrabasic types all seem to be represented.

The Charnockites of Ceylon are stated to differ from the Indian Charnockites in certain respects, *viz.*, in the almost complete absence of microcline, the widespread distribution of calcite, the prevalence of micaceous types and in the intercalation of numerous bands of garnetiferous leptynites.

Wanni gneisses.—A distinct group of reddish, pink or buff coloured gneisses and granulites of intrusive appearance is found in the northern half of the island. The

different types of this series are all characterised by (1) the paucity of ferro-magnesian minerals, (2) the abundance of magnetite, and (3) the comparative abundance of monazite.

These seem to correspond petrologically to some of the newer granites or gneisses of Peninsular India which have been found intruding the Charnockites.

Pegmatites and basic dykes are also found and among the latter, dolerites, peridotites and pyroxene scapolite dykes have been noted.

Among the economic minerals found and worked in the island, graphite, various gem stones, mica, thorianite, monazite and zircon sands are the most important.

B. R. R.

Diet and Climate.*

DR. CHICK'S "Cantor Lectures" on "Diet and Climate" cover a wider field than their title indicates. While she deals at length with the specific question of ultra-violet light and sunshine in relation to vitamin D, calcium metabolism, rickets, osteomalacia, etc., she has included also sections on diet as influenced by locality, race, and custom. In the first lecture she points out that one of the first important clues as to the cause of rickets was found in the study of its seasonal incidence and geographical distribution. As long ago as 1890, Theodore Palm put forward the theory that rickets is a disease of sunless places. His theory, broadly speaking, was correct, but it was not until over 30 years later that the reason *why* rickets tends to be a disease of sunless places was discovered. The explanation, which is at once remarkable, unexpected, and completely satisfying, was provided during the years 1918–30 as a result of the labours of many investigators working independently at different aspects of the problem in their respective countries. No single worker can claim credit as the discoverer of the cause of rickets.

Dr. Chick comments on the existence of rickets, and especially osteomalacia, in Northern India and China. In these regions there is plenty of sunlight capable of transforming the eyesterol normally found in the skin into vitamin D, but there exist "social customs which hinder access to fresh air and sunshine for women and children". At the same time there tends to be a deficiency of mineral salts in the diet. "Vitamin D can only control and correct the metabolism of lime salts and phosphates if these are present in adequate quantities in the diet; sunshine can only provide vitamin D if the inhabitants take advantage of the supply thus provided."

Wilson has shown that rickets and osteomalacia occur in Kashmir even in villagers fully exposed to sunlight. Here, it seems, the chief factor in the causation of these diseases is mineral deficiency rather than lack of vitamin D. The administration of tri-calcium phosphate has proved more effective in treatment than cod liver oil. As a result of the lack of calcium salts and phosphates in the diet, vitamin D, derived from sunshine, is unable to fulfil its proper function.

The lecturer emphasises the association between a high intake of milk and its products and good physique. As McCollum has remarked, "Wherever dairy animals are abundant in proportion to the population and their products form a staple article of diet, fine physical development is seen without exception." In India, McCay was the first to suggest a relationship between the physical characteristics of the various peoples and their staple diet. His investigations have been confirmed and extended by McCarrison, and precisely parallel observations have been made by workers in other parts of the world—notably by Orr and Gilks in East Africa. In England it has been amply demonstrated that an improvement in national physique could be brought about by an increased consumption of "protective" foods, notably milk.

Dr. Chick concludes with some wise remarks about the need for common-sense in applying in practice the scientific principles of nutrition:

> "A great deal of exact knowledge is now available and ready to be applied, but dietetics is not an exact science, and the application of the science of nutrition to the art of dietetics needs to be made with common sense and with intelligent adaptation to the particular circumstances. For example, it is vital that the Madrassi peasant or the Malay coolie should be weaned from rice

* The Cantor Lectures. "Diet and Climate" by Harriette Chick, C.B.E., D.Sc., *Journal of the Royal Society of Arts*, Sept. 13 and 20, 1935.

that is highly milled and polished and persuaded to take it with the bran and germ adhering to the grain. But it is not only silly, but also misleading, to tell the poor English working woman that she must pay more to secure 'unpolished rice' for her occasional rice pudding. In any case, the milk in the pudding and the egg, if present, will correct the deficiency of the highly-milled rice, even if the effect of other constituents of the diet is disregarded.

The use of pasteurised or boiled milk is another example. Milk so treated has a slightly impaired nutritional value, it loses most of its antiscorbutic value, which is never great, and some portion of its content of lime salts is converted to a less digestible form. In this country, however, the heating of milk before consumption is a necessity, since the danger of milk-borne disease is so great. Tuberculosis alone is widespread among our dairy cattle and is a menace to children taking large amounts of raw milk. Yet there are people who insist on the need for raw milk on dietetic grounds, although the defects in heated milk can be simply repaired by giving a little extra fruit juice or vegetable food.

These examples will suffice to show the need for common sense, and the dangers of faddism, in applying the results of scientific investigation to the practical problems of diet.

There remains the economic difficulty of providing a perfect diet upon inadequate means. The provision of cheap milk for school children by the local authorities is an important step in the direction, and other ways of encouraging the consumption of dairy products should be welcomed. In any case, the spreading of knowledge and the popularising of the less expensive 'protective foods' should do much to secure improved nutrition for our own population."

W. R. A.

Andrew Carnegie.

THE Centenary of the late Andrew Carnegie will be celebrated on November 25, 26 and 27 in New York, Pittsburg, Washington and other cities, according to an announcement made by Dr. F. P. Keppel, President of the Carnegie Corporation of New York, the largest of the six Carnegie Foundations in the United States.

Andrew Carnegie was born on November 25, 1835, in a weaver's cottage in Dunfermline, Scotland, the ancient Caledonian capital from which his family emigrated to America in 1848. It was in Dunfermline that Carnegie built his first library and began in 1881 his series of library benefactions that continued until 1917, by which time he had built 1,946 free public libraries in the United States and 865 in other parts of the English-speaking world.

The six Carnegie trusts in the United States are: Carnegie Institute of Pittsburg (1896) which conducts an Institute of technology, a museum of fine arts, a music hall, a museum of natural history, a public library and a library school; Carnegie Institution of Washington (1902) devoted to scientific research; Carnegie Hero Fund Commission (1904) to recognise heroic acts performed in the peaceful walks of life; The Carnegie Foundation for the Advancement of Teaching (1905) to provide retiring pensions for teachers and to advance higher education; The Carnegie Endowment for International Peace (1910) to serve the purpose indicated by its name; and Carnegie Corporation of New York (1911), for the advancement and diffusion of knowledge and understanding among the people of the United States and the British Dominions and Colonies.

The four British Carnegie Trusts are: Carnegie United Kingdom Trust; Carnegie Dunfermline Trust; Carnegie Trust for the Universities of Scotland; and Carnegie Hero Fund Trust.

—*Science*, 1935, **82**, 365.

Medicine-Man of the Red Indians.*

A MASTERLY treatise on the *Shaman* or the medicine-man of the Red Indians of the New World, written by a well-known professor of the Medical faculty of the Western Reserve University, has recently been published, and this should prove invaluable not only as an authoritative source of reference, but also as a model for future investigations on the medicine-men of the primitive tribes of other parts of the world. The work is further of special value in that it gives a succinct and concise account of the past history of the Red Indians and their influence on the development of the vast continents which have been their home from almost prehistoric times. Their present position is also discussed, and the author remarks that "while four hundred years is not a long time in the history of a race, it is sufficiently long, in a casual study such as I have given him, to obtain a fair conception of his past and to anticipate his destination. His tragic past is closed as the tide of empire westward took its way, and with this ends our theme of the aboriginal in his native state." The future is in the lap of the gods, but reading between the lines there seems little doubt that just as his medicine-man has passed so will the Red Indian in most parts of America under the stress of the modern day conditions to which, in spite of the attempts of the various authorities for his education and civilization, he has not been able to adapt himself; in certain areas he is already "gradually merging with the invading races of the Caucasian and the Negro".

In an introductory chapter the author starts with an attempt at a reconstruction of the family tree of the "American Indian". The name Indian, as the author points out, was a misnomer as applied to the inhabitants of the Americas when Columbus discovered the New World, for they are in no sense allied to the Indian of the Old World. From a careful review of the available evidence he concludes that the American Indian is not the primitive inhabitant of the New World, but migrated to North America some eight to twenty thousand years back across the Behring Strait route from the East Cape, Siberia to Alaska and later "penetrated every portion of the New World from Alaska to Patagonia". All Red Indians, however, did not migrate at the same time nor were they all of a single stock only. After referring to the distribution of the three main divisions of mankind—the Caucasoid, the Mongoloid and the Negroid—the author describes in some detail the racial characteristics of the American Indian, and agrees with the view of most authorities that he belongs to the Mongoloid division of the human race.

Defining Culture as "everything that man does, creates, thinks about and imagines, and hands to the next generation by precept. In short, it is all human behaviour, which is developed and used daily and which is handed down to the next generation by teaching and example," the author asserts that the cultural elements or traits brought with him by the American Indian from the Old World consisted of the "dog, the firedrill, the harpoon, basketry, ideas concerning the causes and cures for disease, family groups and some ceremonial rites." From this meagre inheritance the American Indians developed the highly evolved culture of the Aztecs and the Mayas in Central America and of the Incas of Peru in South America, without any extraneous influences. The two continents of North and South America are divided, on the basis of the different tribes inhabiting the various regions, into fifteen areas of Indian Culture. A short survey of the cultural development in the different areas and their history so far as known is followed by an account of their relationships and racial origin, their religious beliefs, their medicine-men and their conception of disease. After discussing the various tribes and their medicine-men, the author holds forth the view that the most universal and popular theory of the cause of diseases amongst the Red Indians is that of "disease-object intrusion". This is the theory which holds that sickness is due to the presence in the body of some foreign object, such as a fish-bone, a stick, a stone, or a bit of hair. After that, the following causes for illness, given in the descending order of their importance, may be listed: "soul-loss, sorcery, spirit intrusion, and finally, breach of taboo." Every tribe had and has its medicine-men who, before being recognised as such, had to undergo various

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* *The Medicine-Man of the American Indian and His Cultural Background.* By W. T. Corlett. (C. C. Thomas, Springfield, Illinois.) Pp. ix + 369, 23 plates, 1935. Price $5 or *Sh.*22/6.

kinds of training, most of which was useless but some had an intrinsic value. The supernatural, of course, played a very important part in the Indian's healing ceremonies, but the medicine-man's job was to inspire confidence and faith on the part of the patient, and as in all medical practice, he used commonsense as the basis of his treatment.

The author includes several references to the surgical skill of the primitive medicine-men or *Shamans* and he quotes from Moodie about the surgical knowledge of the pre-Columbian Peruvians as follows :—" Their surgical attempts are truly amazing and include amputations, excisions, trephining, bandaging, bone transplants (?), cauterization and other less evident procedures." A chapter deals with child-bearing and the various attendant customs and ceremonies as also the part played by the midwife amongst the different tribes. Following such authorities as Morgan and Renaud, the author is of the opinion that " food played an important part in the distribution and culture of the Indian tribes of both South and North America," and he attributes the high stage of evolution of the culture of some of the tribes to their cultivation and use of the Indian *corn*—the maize—just as the " culture of the Orient was founded on rice, and that of Europe on wheat and other cereals". The importance of food in connection with the activities of the medicine-men is considered and the Materia Medica of the different tribes is described in some detail. The fantastic dress of the medicine-man, his medicine-bag, medicine-pipe and the sweat-house are described, and he is considered as " the mediator between his people and the Great Spirit " in trying to cure diseases.

The work is well illustrated and the detailed bibliography and the carefully prepared index greatly add to the usefulness of the work. It is indeed one of the most up-to-date books on the subject, and both the author and publisher are to be congratulated on its production.

B. P.

Science Notes.

Production of Gases during Decomposition of Cane Molasses in the Swamp Soil.—G. Narasimhamurthy, M.Sc., Department of Biochemistry, Indian Institute of Science, Bangalore, writes :—Attention has already been drawn [Bhaskaran *et al.*, *Proc. Ind. Acad. Sci.*, 1934, 1 (B), 155] to the fact that a number of gases are formed during decomposition of cane molasses in the swamp soil. In view of the importance of the gases in relation to plant life, a few quantitative studies were carried out, examining the gases produced during two successive seasons, one hot and the other cold. The gases were collected over water and analysed according to the procedure outlined by Kane, Krishnaswami and Watson [*J. Ind. Inst. Sci.*, 1934, 17 (A) 33]. The results have been presented in Tables I, II (*a*) and II (*b*) :—

TABLE I.

Rate of Evolution of Gases.

Season : November—December 1934.

Time in Days	1	2	3	4	5	6	7	8	9	10	11	12
Vol. of gas collected in c.c.	Nil	Nil	Nil	98·4	201·1	121·2	69·1	44·8	40·8	27·7	Nil	Nil (No further evolution)

TABLE II (*a*).

Distribution of Gases.

Season : November—December 1934.

Time in Weeks	Percentage of the total volume						
	Carbon dioxide	Oxygen	Unsat. Gases	Carbon monoxide	Hydrogen	Methane	Nitrogen
	2·0	4·4	Nil	Nil	51·2	4·7	37·7
	[illegible]	Nil	Nil	Nil	1·0	12·7	75·3

TABLE II (*b*).
Distribution of Gases.
Season: April—May 1934.

Period in Days	Percentage of the total volume						
	Carbon dioxide	Oxygen	Unsat. Gases	Carbon monoxide	Hydrogen	Methane	Nitrogen
1— 3	13·0	3·9	Nil	Nil	7·5	2·3	73·3
4— 7	11·7	4·5	Nil	Nil	0·6	3·3	79·9
8—10	12·3	7·7	Nil	Nil	0·8	3·3	75·9
11—14	13·8	2·4	Nil	Nil	1·4	5·3	77·1
15—21	4·2	3·2	Nil	Nil	0·5	2·5	89·6
22—28	8·1	3·2	Nil	Nil	Nil	2·9	85·8

There was greater production of gases during the warm months than during the cold ones. The evolution of gases continued over a number of days, even long after the sugars were completely used up. The proportion of the gases was largely determined by the amount of free air space above the fermenting medium: there was increased production of hydrogen and methane with the reduction of air space, while increased air supply led to greater production of CO_2. Under no condition, however, was either carbon monoxide or any of the unsaturated gases produced. The large quantities of nitrogen and small amounts of oxygen present in all the samples were traceable to the air originally present in the soil system.

The author's thanks are due to Dr. K. R. Krishnaswami for much valuable advice and Prof. V. Subrahmanyan for his kind interest in the work.

* * *

The Thermal Structure of the Upper Air over a Depression during the Indian South-West Monsoon. N. K. Sur (*Indian Meteorological Department, Scientific Notes*, Vol. VI, No. 65).—A depression developed in the Bay of Bengal in the first week of September 1932 and passed through Orissa, the Central Provinces and Central India. From sounding balloon ascents at Agra during the week, it is found that temperature at upper levels below the tropopause at first decreased on successive days as the depression increased in intensity and approached Agra. When the depression deepened further and became practically stationary in the neighbourhood of Agra, an exception is noticeable at the levels between 8–12 gkms., where no fall of temperature occurred. At this stage the level of the tropopause above the depression was lowered with an increase of temperature in the lower stratosphere and a decrease at levels immediately below the tropopause. (*Author's Summary.*)

* * *

Inheritance of purple pigmentation in Setaria Italica, *the Italian millet.*—G. N. Rangaswami Ayyangar and his assistants (*The Indian Journal of Agricultural Science*, Vol. V, Part II), summarise their conclusion in regard to the inheritance of this purple pigmentation:—"Plants of the Italian millet are either pigmented (Anthocyanic) or without purple pigment (non-pigmented). The former condition is dominant and arises by the basic presence of a factor P. There are various manifestations and intensities in this pigmentation. A factor I determines a manifestation in intensity. This is dominant to a manifestation in a weaker depth. The degree to which P is operative in addition to being greatly influenced by the presence of I, is conditioned by two other factors V and H, which determine the alacrity with which P manifests in the vegetative or earhead parts. The interaction of P, I, V and H factors produces the diversity of forms characterising varieties of this millet.

Data from over 420 families are presented in support of the above hypothesis. A number of artificial crosses furnish confirmatory evidence."—(*Author's Summary.*)

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Pungency in Chillies.—The inheritance of pungency in chillies (*Capsicum Annam* L.) forms the subject of an interesting study by A. B. Deshpande (*Ind. Jour. Agr. Sci.*, **5**, 4). The results are as summarised below:—"(1) Pungency is definitely a heritable character. The degree of pungency, however, is found to vary considerably with environment such as soil, climate, manurial treatment. (2) The genetic results show that pungency is a simple monogenic character dominant to non-pungency and is determined by a single factor which we have termed C. (3) 'Calyx not enclosing fruit base' has been found to be dominant to 'calyx enclosing fruit base" on a 3 : 1 basis. (4) Both pungency and the nature of calyx, when studied together, have been found to segregate on di-hybrid basis, each quite independently of the other." (*Author's Summary.*)

* * *

Preparation of Beer by the Nagas.—No *Ao* drinks if he can get rice beer (yi C, azu M).[1] Even if a man goes fishing he will take drinks down to the river. At festivals large quantities are drunk, and most people are fairly merry, but no one has ever seen an *Ao* dead drunk or heard of an *Ao* drinking himself to death. On the other hand, many men keep themselves alive for months on rice beer. "Madhu", as rice beer is called in Naga-Assamese, is so sustaining that in the case of old men it often takes the place of solid food. It is made as follows: Yeast (piyazi C; pazai M) is first prepared. To make it, husked rice is soaked in

[1] These remarks do not apply to the Christians who are strictly forbidden by the American Baptist Mission to partake of alcohol in any form.

water in an earthenware pot. The water is drained off and the rice pounded up with likok leaves and spread out on a winnowing fan. This dough is then divided up into four, six or eight elliptical cakes and a similar number of square cakes. The elliptical cakes are called male cakes and the square, female cakes. A layer of rice husks is then spread on a bamboo tray, and over the husks sugar-cane leaves, "to make the yeast sweet". The damp cakes are put on the leaves and after some old yeast has been crumbled over them they are left to dry till the morning of the sixth day, when they are considered ready for use.

To prepare "Madhu" rice is boiled and spread on a mat and allowed to cool. Then pounded yeast and a small quantity of rice husks are mixed with it, the woman who is preparing it saying: "Enter the plantain tree, climb the sugarcane, and be sweet." Immediately after it is mixed it is put into a basket lined with leaves. On the evening of next day it is put into tall baskets lined with plantain leaves and the juice is allowed to drain off at the bottom. This juice is the drink known in Naga-Assamese as "rohi madhu" (mechemzu C; mechem M). It is of about the potency of claret, and is the favourite drink of well-to-do men. To the English palate it is too sticky, and often too sweet to be a "clean" drink, but is very stimulating and by no means to be despised half-way up a long hill. For a thirst quencher the *Ao* prepares "Saka madhu" (tesenzukyi C; azu techenlak M), a drink resembling very thin gruel, and less potent than the lightest beer. To prepare it fermented rice from which the "rohi madhu" has drained is put into a sieve (sanku C; changku M), and hot or cold water is poured on to it. The milky fluid which results is the ordinary household drink of an *Ao* family.

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Archæological Trial Excavations at Patna—Discovery of Ancient Wooden Foundations.—On receipt of a report from the Chaukidar at Kumrahar (near Patna) that traces of some wooden structure have been exposed in a brick-field, the Archæological Superintendent of the Central Circle, Patna, proceeded to examine the nature and extent of the ancient remains by trial diggings. The result was the discovery of a long wooden platform, about 100 feet in length and 5′–6″ in width, and 7′ in height running north and south. The bottom of this structure is 22 feet below the level of the road nearby and seems to continue at either end. Wooden structures were unearthed previously at the Bulandibagh and Kumrahar excavations by the Archæological Department, and another has recently been brought to light by the Public Health Department in course of laying sewage pipes to the east side of Kankarbagh Road. The minor antiquities found at Gonsai Khanda consisting mainly of small pottery cups, potsherds and terracotta balls, etc. are similar to those discovered at Kumrahar and Bulandibagh and may be attributed to the Mauryan epoch. A small walling of Mauryan bricks was also found at right angles to the wooden structure near the top. The particular purpose for which all these wooden structures at the ancient site of Pataliputra were constructed is not determined. The Bulandibagh pieces might well have formed part of the old wooden palisade of Pataliputra but the Gosai Khanda construction is more likely to be a coffer dam erected in connection with training and revetment of a river bank or the construction of a wharf. The favourable situation of ancient Pataliputra at the confluence of the Son and the Ganges, made it a great centre of inland water-borne traffic, and there must have been a river port of considerable importance at Pataliputra, and wharfs and docks must have been found necessary, where such coffer dams of which the remnants have been laid bare were sometimes constructed.

* * *

Some Early Indian Paintings Discovered by Prof. Jouveau-Dubreuil in Tinnevelly District.—At a recent meeting of the Archæological Society of South India, Messrs. T. N. Ramachandran and C. Sivaramamurti, exhibited copies of some early paintings discovered on the ceiling of the mandapa and on the pilasters of a cave temple in Tinnevelly District. The temple bears an inscription of the 12th–13th century A.D. relating to the Pandyan King Srivallabha. The paintings appear to be of Pandyan art, and no paintings representing this were previously known. The paintings are relatively rich in *rekha* or line and lacking in *bhushana* or ornament.

Mr. Paramasivan gave an account of the technique of the process of painting used. The pigment consists of a mixture of yellow particles (yellow ochre) and much-faded blue particles (indigo). The binding medium appears to have been starch paste but this is very far from certain.

* * *

The Patwar Meteorite.—At the ordinary monthly meeting of the Asiatic Society of Bengal held on 4th November 1935, Dr. A. L. Coulson presented an interesting account of the meteoric shower which occurred at about 14.20 hours on the 29th July 1935, near the village of Patwar (23° 9′: 91° 11′), Bhatupara, Gotrasal, Fatehpur and Majhipara near Nangalkot, some 20 miles due south of Comilla, the chief town of Tippera district. Two months ago Dr. Coulson read a paper on the Perpeti meteoric showers (see *Curr. Sci.*, 1935, **4**, 120). "Patwar is only some 17 miles south-east of Perpeti, also in the Tippera district. The two falls, however, are distinct but it would be interesting to learn of any other occurrence of two separate meteoric showers within 17 miles of each other after a lapse of two and a half months.

"So far three specimens, totalling 35,013.5 grams, which fell at the three first-named villages have been recovered, the largest (23,111.6 grams) falling at Patwar which gives its name to the fall. However, two small additional stones from the villages of Fatehpur and Majhipara have been recovered and sent to the District Magistrate, Comilla.

"The fall was accompanied by the usual phenomena of light and sound. A dazzling light following a "loud rumbling noise" is supposed to have been the first indication to the villagers of the fall of the meteorite. The sound is stated to have been so loud and continued, that those in the police thana at Chauddagram, some 7 miles to the north-east of Fatehpur, the nearest locality to the thana from where stones were recovered, distinctly heard it. Four reports "like thunder" were heard in quick succession. One observer adds that a peculiar sound like "that of an

aeroplane" followed the reports; this may have reference to the passage through the atmosphere of the disrupted members of the parent meteorite.

"The largest specimen penetrated to the ground to a depth of 34 inches.

"The parent meteorite appears to have been moving in a west-south-westerly direction. The smallest pieces fell first, followed in succession by the larger. The total rectangular area covered by the shower is roughly about 4½ square miles, the length being some three miles in the direction E.S.E.-W.S.W.

"The meteorite has great interest on account of its rather rare composition. It belongs to the group of mesosiderites, being a siderolite intermediate in composition between a stone and an iron. It contains large crystals of olivine and masses of nickel-iron of fair size. It is composed chiefly of nickel-iron with olivine, enstatite and bytownite, with smaller amounts of schreibersite, troilite, oldhamite, lawrencite and hydrocarbons. Its specific gravity is 4.21."

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The Doon School.—India's First Public School, the Doon School, run entirely on lines on which Schools in England are conducted, was opened by H. E. the Viceroy on the 27th October. There are in India institutions on a residential basis, but they invite particular class of students, *e.g.*, chiefs' sons, or are intended to prepare for a particular career in later life, *e.g.*, army. The School, which is the first of its kind in the country, and at present considered to be of the nature of an education experiment, owes its inception to the late Mr. S. R. Das, who was the originator and founder of this great venture. It is run entirely on British lines and the Principal, Mr. A. E. Foot, is one who has considerable experience of Public Schools in England. The main purpose of the institution will be to provide education to young men and women, which will enable them to become useful citizens of the country. This education will help in the formation of character, "which will develop our citizens with a high sense of honour, of responsibility and of discipline, qualities which are absolutely essential to all services in public life." There are boys in the School from all Provinces and many Indian States. All religions are respected. The School is open to Indians of all castes and creeds and will be run as an individual unit with a purpose, a function and aim all its own.

The School, at present, has a strength of 70, which will be raised to 180 by next February and the School will ultimately provide education for 400 boys. The Doon School is located in an estate known as 'Chand Bagh' in Dehra Dun. Negotiations are in hand to acquire an adjacent estate known as Skinnes' estate, which will provide for further extension.

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Asiatic Society of Bengal.—Dr. Sunder Lal Hora of the Zoological Survey of India gave a paper on "Recent Indian Cases of Live Fishes Impacted in the Food and Air Passages of Man" at the Medical Section of the Asiatic Society of Bengal on the 18th instant. Lt.-Col. B. G. Mallya dealt with the surgical aspect of such cases. It is understood that the paper, which is bound to be of great medical interest, will be published shortly.

It was understood that Dr. Hora would have been able to exhibit a specimen of a small fish impacted in the pharynx of man, preserved in the Pathology Museum of the Medical College, Calcutta, but unfortunately, the specimen had crumbled into pieces and was not available for exhibition.

* * *

The Industries Conference.—The Seventh Industries Conference was held at New Delhi, on the 28th and 29th October, and was opened by Sir Frank Noyce, Member for Industries and Labour. The Conference has concentrated its attention on the development of the Handloom Industry and at the last Conference held in July 1934, a sum of Rs. 5,70,000 was allotted to Provincial Governments for expenditure on approved schemes during the 17 months from November 1934 to March 1936. The schemes are of varied character, including the training of weavers in improved methods of production, establishment of sales depots and weavers' co-operative societies for marketing handloom products and introduction of new patterns, new designs and improved appliances. The Conference reviewed the progress achieved in the working of the various schemes. The schemes were initiated only recently, and much could not have been achieved. The prospects of success are however indicated; and it is expected that for the next year more grants would be made available. The Conference has agreed to hold an exhibition of handloom machinery and fabrics in February 1936, (9th-24th) at Patna and will organise a competition for handloom weavers. The Conference also discussed questions relating to the abolishing of restriction in respect to fees charged in technical institutions from students belonging to the Province and those coming from other provinces. Another important subject discussed was the regulation of labour (particularly child labour) in unregulated factories and workshops.

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The Imperial Sericultural Committee, which was established in accordance with the recommendations of the Tariff Board, held its second meeting on the 31st of October. It may be recalled that at the first meeting held on February 25th grants amounting to Rs. 93,000 were allotted to various provinces for working out schemes, connected mainly with the increase of the production of disease-free seed and the investigation of silk-worm diseases. The Committee reviewed the work and decided to recommend further allotments from the Sericulture Fund for 1936–37. The proposals for the improvement and development of the Sarrar Silk Industry in Bihar and Orissa and for the expansion of the sericultural farm in Shillong, were considered and approved.

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The Institute of Engineers, India, has been granted the Royal Charter. This is the first instance of the Charter being granted to a professional body, which has its origin and function solely in India. The Institute was formally constituted as a corporate body with Sir Thomas Ward as the first President on September 13, 1920, and was inaugurated by Lord Chelmsford on February 23, 1921.

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Education and Vocational Training.—In the course of his inaugural sessional address at the

opening of the ninety-fourth Session of the College of the Pharmaceutical Society, on October 2, Sir Frederick Gowland Hopkins discussed, among other topics, the one on "how far vocational training is compatible with true education in which a subject is studied for its own sake as an intellectual exercise." It has often been said that science can only be taught properly when it is taught as pure science without reference to its applications. This claim is justified to the extent that vocational needs must not make the teaching of science so one-sided that the student risks missing the intellectual stimulus which the great generalisations of science provide.

"Teachers of applied scientific subjects will be grateful to the president of the Royal Society for his declarations that the skilful teacher of students whose ultimate aim is to apply science in practice, can illustrate general principles adequately while selecting facts and aspects which have a permanent vocational value. Indeed, for the encouragement of the average student, it is important that the reality of this permanent value should be part of his faith. Without it he can never be an enthusiast for his calling. The preference for vocational training may well be based on the Anglo-Saxon preference for action rather than thought and for practice rather than theory, but it is an attitude of mind having in it the seeds of certain dangers. Indeed, a distrust of theory has sometimes kept Great Britain from being in the van of intellectual and not less of commercial progress."—(*Nature*, Oct. 12, p. 614.)

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Counting by Eights.—In an interesting article published in the *School Science and Mathematics* (April 1934), E. M. Tingley, 221, North Cuyler Avenue, Oak Park, Illinois, U.S.A., has made a vigorous plea for calculating by *eights*, not by *tens*. Humanity has been adopting the metric system for over eight centuries. Mr. Tingley considers that the base eight is more natural. We have two eyes and two hands; we prefer to double or halve things. "Halves of things are much easier to comprehend than thirds or fifths, because halves are simpler and fewer. Therefore we should also use measures and an arithmetic base containing only even factors to treat the preferred even divisions. Eight gives the best even scale or base for this arithmetic." The decimal counting and calculating scale contains the odd fives, and it is said, calculation based on fifths and thirds is troublesome.

The question is a very serious one, and to discard a system which has been in vogue ever since the present method of writing numbers was devised (750 A.D.) in preference to a new system, it is necessary to have convincing psychological proof. The psychologists should measure our preferences towards the two systems and declare which of them is more natural and simpler to comprehend.

* * *

Synthetic Rubber.—A proclamation has recently been issued by Herr Hitler to the effect, that s the problem of producing synthetic rubber be regarded as definitely solved, the he first factory in Germany for this be begun." Thus to the synthetic productions of more has been added. Rubber is one of the cheapest and most plentiful of raw materials, and attempts are not wanting for cheapening it further by systematic work on the plantations and in the factory. The German chemists at the Interssen Gemeinschaft have now succeeded in supplanting rubber by an artificial product and further developments are awaited.

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Real Silk Industry.—So much is being written and spoken about the artificial silk industry, that an impression is gaining ground that the real silk industry is doomed to extinction. An article appearing in a recent number of *Chemical Age* (Oct. 12th, 1935) by A. T. Hall, on real silk, however, serves to give a scientific picture of the real position.

For many purposes, pure silk cannot be replaced by rayon and indeed in some lines, "pure silk is ousting rayon." Thus in the hose industry, pure silk is becoming increasingly popular. Rayon becomes much dearer in the form of fine yarns, while the price of fine pure silk yarns is not much different from that of coarser yarns.

In the actual processing, the degumming of silk has attracted considerable attention at the hands of the research chemist. Sericin is the gum which cements together the raw silk threads which when taken from the cocoon are harsh, lustreless and coloured, while possessing strength. Sericin can be removed by aqueous solutions of alkalies and in recent years, sodium silicate is being used extensively together with soluble sulphonated oils. Degumming gives soft, lustrous silk, which is almost colourless. There are actually three sericins, distinguished as sericin A, sericin B and sericin C. Sericin B is a very valuable compound as it possesses excellent dispersive and penetrating properties which become effective when degumming liquor is used to assist in the dyeing of silk yarns.

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Coal Hydrogenation Petrol Plant.—The opening of the petrol plant by Mr. Ramsay MacDonald on the 15th October at the Billingham Works of the Imperial Chemical Industries, Ltd, has brought to a practical commencement an enterprise which marks a revolution in fuel technology. The plant is the first in the world for the hydrogenation of bituminous coal. The process, due to Prof. F. K. R. Bergius, consists essentially in hydrogenating raw coal cleansed to less than 2½ per cent. of ash and ground up to a paste with oil to give a 50 per cent. coal-in-oil paste. This is injected into converters against the working pressure of 250 atm. and mixed with hydrogen. The mixture is heated up to 450° C. and the hydrogenation takes place at a temperature of 450° C. and 250 atm. pressure. A small heavy oil fraction containing the unconverted coal (about 5 per cent. by weight) and ash separates and is treated for oil recovery, the coke residue being used as a fuel. The major part of the coal is transformed into lighter oils which are separated and distilled into heavy oil, middle oil and petrol. Heavy oil is further hydrogenated to give middle oil and petrol. The middle oil is hydrogenated again in vapour phase converters, in which the vaporized light oil and hydrogen are passed over a solid catalyst. The crude vapour phase product is distilled, the residual middle oil being separated from petrol and treated again. The whole

of the coal is thus transformed into small consumable solid residue, gas and petrol.

The hydrogenation of coal is a self-contained process as the only raw materials used are coal and water, and if desired petrol can be the sole end product. Conditions can, however, be arranged to give fuel oil, diesel oil, petrol and liquefiable hydrocarbon gases such as propane and butane. The company started work on hydrogenation in 1927, and since that date has spent over a million pounds over research on that one subject, and in 1930–31, a small plant was installed for treating 15 tons of coal per day. The present output is 400 tons of petrol per day representing a total annual output of 45,000,000 gallons, forming only 4 per cent. of the country's consumption of petrol. The production, for a long time to come, may be in the nature of a supplement rather than a principal source, but still from this and other plants that might be erected in due course, there is reasonable chance of this supplement increasing in quantity. 4 tons of coal are required to produce about a ton of petrol.

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Arctic Exploration.—An extra strong wooden ship whose ultimate duty will be to become frozen in Arctic ice and drop into ice fields with high latitudes will be completed early in 1937. Professor Wiese, the Soviet explorer, has announced, that in general, the design of the ship will form that of *Fram* used for similar duty by the Nansen expedition to the Arctic in 1893–96. The chief object of the expedition which will use the new ship will be a thorough study of the deep parts of the Arctic basin which are covered the year round with ice crust so thick that the strongest ice breakers cannot pierce it.—(*Science*, 1935, **82**, No. 2127, Suppl., pp. 14.)

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British Industries Fair, 1936.—The next British Industries Fair will be held in London from February 17th to February 28th, 1936. Information regarding the Fair can be obtained from the High Commissioner for India, India House, Aldwych, London, W.C. 2.

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Chemical Research in China.—"The rapid growth in the amount of chemical research, both pure and applied, in China during the last decade, is phenomenal. Research institutes are springing up everywhere, and a genuine effort is being made to give experience in research as an integral part of the training of every University Science graduate. Attention is being continually devoted towards the scientific study of the old chemical industries which flourished in ancient China. The British Boxer Indemnity Fund, for example, is supporting research at Yenching University aiming to improve the pottery industry of Peng-Cheng, Shansi. At Nankai University and the Golden Sea Research Institute, projects of a similar nature are being undertaken. Specialists on rural economics are stressing for China, improvement and further development in the village industries.—(*Ind. Eng. Chem., News Edition*, 1935, **13**, 358.)

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Consequent to the retirement of Diwan Bahadur Sir T. Vijayaraghavacharya, the following officiating arrangements have been made from 26th October 1935:—

Mr. B. C. Burt, Vice-Chairman of the Imperial Council of Agricultural Research.

Dr. F. J. F. Shaw, Agricultural Expert to the Imperial Council of Agricultural Research.

Rao Bahadur B. Viswa Nath, Director, Imperial Agricultural Institute, Pusa, in addition to his duties as Imperial Agricultural Chemist.

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Dr. S. K. Mitra, Professor of Physics, University College of Science, Calcutta, has proceeded to Europe on a Travelling Fellowship under the Calcutta University, for the purpose of studying the recent developments in wireless and television.

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Dr. S. N. Chakravarthy, and Messrs. K. S. Venkataramani and Ramaswamy Sivan have been declared elected by the Senate to the Syndicate of the Annamalai University.

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It is understood that the Senate of McGill University of Canada has sent felicitations to its oldest graduate—Dr. Griffith Evans of Bangor (Wales), who recently celebrated his 100th birthday. Dr. Evans took his M.D. Degree at McGill in 1864.

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Noble Lauriateship for 1935.—Chemistry: Professor Joliot and Madame Curie-Joliot. Physics: Professor James Chadwick. Physiology and Medicine: Professor Hans Spemann.

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Cornell University.—A gift has recently been made to the University by Dr. L. H. Bailey, Professor Emeritus of Agriculture and Mrs. Bailey of one of the most extensive herbariums in this country. This collection comprises over 125,000 mounted herbarium sheets, especially rich in cultivated material, and there are also included in the gift 4,000 technical books related to horticulture and botany, thousands of photographs, working equipment, etc., the buildings which house the collection, and about 0.25 acre of land. In accepting the gift the University has authorized the establishment of an administrative unit in the College of Agriculture to be known as the Liberty Hyde Bailey Hortorium. This will be under the direct supervision of a staff member and with a full-time curator and an advisory board consisting of the supervisor, the curator, representatives of the major fields of plant science, and two members at large. One or more graduate fellowships to be known as the Liberty Hyde Bailey Botanical Fellowships will also be established.—(*Experiment Station Record*, Vol. 73, No. 2.)

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Bibliography of Soil Science, Fertilizers and General Agronomy, 1931–34.—The Imperial Bureau of Soil Science has recently published this bibliography consisting of over 6,000 references to papers, bulletins and reports published throughout the world in the years 1931–34, and dealing with pure and applied soil science. The volume contains (1) an index to the decimal classification, (2) an alphabetical cross index to every subject on which the papers listed have been written, (3) an author index containing over 4,000 names, and (4) a list of abbreviations used, and the full titles and places of issue (where known) of 800 journals, etc., from which the references in the bibliography have been taken. The bibliography containing 504 pages, is bound

in cloth, and is priced 25*s*. net, and can be obtained post free, from the Imperial Bureau of Soil Science, Harpenden, Herts, England.

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The Indian Physico-Mathematical Journal, September 1935.—*The number of representations of a large number as a Sum of* n *non-negative* nth *powers :* By S. Chowla. The following theorem is proved: For a fixed value of n, $r_{n,n}(N) \neq O(1)$ *i.e.*, for an arbitrary value of A, we can find infinitely many values of N such that $r_{n,n}(N) > A$. The symbol $r_{s,n}(N)$ denotes the number of representations of N as a sum of *s nth* powers $\geqslant 0$.

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The Mathematics Student, June 1935.—(1) *On G-Functions in General :*—By Hans Raj Gupta. In previous papers, Mr. Gupta has studied some properties of $G(n, r)$ where

$$(x+1)\ (x+2)\dots(x+n) = \sum_{0}^{n} G\ (n, r)\ x^{n-r}$$

In the present paper, the author attempts a general definition for the function $G(x, \rho)$ for all values of x, ρ being a positive integer $\geqslant 1$ and mentions that his results have been useful in a paper of his on "Ward's Numbers" under publication.

(2) *Focal lines of a Cone touching four given concurrent planes :* By A. A. Krishnaswami Ayyangar.

If the planes are parallel to the faces of a tetrahedron, the author proves that the focal lines are parallel to the axes of circular cylinders circumscribing the tetrahedron.

The theorem is the outcome of Mr. V. Ramaswamy Aiyar's paper on "Circular cylinders circumscribing a tetrahedron" in *Math. Student*, Vol. II, No. 3.

A few corollaries are added.

C. N. S.

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Messrs. Chapman and Hall.—We have been informed that Messrs. Chapman and Hall, the well-known publishers of General Scientific and Technical books, have been appointed sole agents for the British Empire, for the CHEMICAL CATALOG Co.. of New York, from 1st November 1934. This news will be welcomed by all, particularly chemists, in all parts of India, as they are thereby enabled to obtain the Volumes direct from Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, London, W.C. 2.

A full list of the books of the Chemical Catalogue Company have been prepared and can be obtained from Messrs. Chapman & Hall, Ltd., London.

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Recent Publications.—Edward Arnold & Co., London :—

Forensic Chemistry, and Scientific Criminal Investigation, by A. Lucas, O.B.E., F.I.C.

The Structure of the Alps, by Leon W. Collet, D.Sc.

The Oyster, and the Oyster Fishery, by J. H. Orton.

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ndian Lac Cess Committee.—The attention s is drawn to an advertisement is issue of the Journal, inviting e post of Director, Indian Lac amkum, Ranchi — Salary Rs. 1,250–50–1,500. Last day for application—14th December 1935.

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Announcements.

Krusadai Biological Station.—The following scale of fees will be levied from post-graduates and under-graduate student parties from Colleges and Universities for services rendered by the Krusadai Biological Station in connection with the collection and study of marine fauna and flora :—

1. Post-graduate workers such as M.A. and M.Sc. students, and Professors doing research.	Rupee one per day for the first three days and annas eight per day for the subsequent days of halt.
2. Under-graduates who come for collection of specimens.	Annas eight per day for the first three days and annas four per day for the subsequent days of halt.
3. The Professors who accompany the under-graduates that do not do research of their own.	Do.

* * *

Discussions at the Indore Meeting of the Indian Science Congress.—The following discussions, which will be held during the meeting of the Indian Science Congress at Indore in January next, are announced in advance in order to enable those who may wish to take part to have an opportunity of preparing their remarks. The following joint discussions have been arranged :—

Agriculture and *Medical Sections*, "The Making of Humus and its Application";

Chemistry and *Physics Sections*, "The Structure of Molecules";

Medical and *Physiology Sections*, "The Problem of Nutrition in India"; and

Botany and *Zoology Sections*, "The Teaching of Biology in Secondary Schools".

The following discussions, confined to single sections, have also been arranged :—

Chemistry Section, "The Scope of Preparation of Fine Chemicals in India", and "The Utilisation of Molasses";

Geology and *Geography Section*, "The Classification of the Archæan Rocks of India":

Botany Section, "The Myxophyceæ", "Saltation in Artificial Cultures of Fungi", "The Standardisation of the Vernacular Names of Indian Plants", "Chromosome Morphology and Polyploidy", and "The Importance of Anatomy and Taxonomy".

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We acknowledge with thanks the receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVI, Pt. 10, Oct. 1935.

"Transactions of the Faraday Society," Vol. XXXI, Pt. 10, Oct. 1935.

"Journal of Agricultural Research," Vol. 51, No. 2.

"Journal of Agriculture and Livestock in India," Vol. V, Pt. V, Sept. 1935.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4323-4326.

"Indian Journal of Agricultural Science," Vol. 5, Pt. IV, August 1935.

"Biochemical Journal," Vol. 29, No. 9, Sept. 1835.

"American Journal of Botany," Vol. 22, No. 8, Oct. 1935.

"The Journal of Institute of Brewing," Vol. XLI, (New Series, Vol. XXXII), No. 10, Oct. 1935.

"Canadian Journal of Research," Vol. 13, No. 3, Sections A and C.

"Chemical Age," Vol. 33, Nos. 848–851.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 10.

"Experimental Station Record," Vol. 13, No. 3, Sept. 1935.

"Indian Forester," Vol. LXI, No. 11, Nov. 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 28–30.

"Bulletin of the Geological Institution of the University of Upsala," Vol. 22, 1930; Vol. 23, 1932.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. 7, No. 2, June 1935.

"Indian Physio-Mathematical Journal," Vol. 6, No. 2, Sept. 1935.

"The Review of Applied Mycology," Vol. 11, Pt. 1, Jan. 1935. (Issued by the Imperial Mycological Institute.)

"Nederlandsch Tijdschrift Voor Natuurkunde," Tweede Jaargang, Nummer 7.

"Mathematics Student," Vol. III, No. 2, June 1935.

"Medico-Surgical Suggestions," Vol. 4, No. 9, Sept. 1935.

"Indian Meteorological Department Scientific Notes," Vol. VI, No. 65. "The Thermal Structure of the Upper Air over a Depression during the Indian South-West Monsoon." By N. K. Sur.

"Nature," Vol. 136, Nos. 3439–3442.

"Journal of the American Museum of Natural History," Vol. 36, No. 3, Oct. 1935.

"The Journal of Nutrition," Vol. 10, No. 3.

"Acta Phytogeographica Succica":—

II. Der See Fiolen und Seine Vegetation, von Sven Thunmark.

III. 1. Life-forms of Terrestrial Flowering Plants I. By G. Einar Du Rietz.

IV. Om Den Vildväxande Skogsalmens Raser Och Deras Utbredning I Nordvästeuropa, av Bertil Lindquist.

V. Vegetation of the Pacific Coast Bogs of North America. By Hugo Osvald.

"The Journal of Chemical Physics," Vol. 3, No. 10, Oct. 1935.

"Indian Journal of Physics," Vol. 9, Pt. VI, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 18, Pt. VI, Sept. 1935.

"Science Progress," Vol. 30, No. 118, Oct. 1935.

"Science and Culture," Vol. I, No. 6, Nov. 1935.

"United States Department of Commerce: Journal of Research of the National Bureau of Standards," Vol. 15, Nos. 1 and 2, July and August 1935.

"The Indian Trade Journal," Vol. CXIX. Nos. 1529–1533.

CATALOGUES.

"Hilger Catalogue G. Astronomical Spectrographs and Spectroscopes," (Messrs. Adam Hilger Ltd., London.)

"Some Mathematicians I Have Met."*

[Prof. Born prefaced his remarks by saying that he was not a professional mathematician and was grateful for being asked to talk not a mathematical problem, but on a general subject. He proceeded to classify the many mathematicians he had met as falling under the three generations of teachers, colleagues or friends, and pupils.]

RECALLING his early days at Breslau where he attended courses of lectures on Philosophy, Chemistry, Physics, Astronomy, Economics and Law, he mentioned the profound impression created by his astronomical studies and by the old Observatory of his College, the instruments going back to the times of Wallenstein and his astrologers, the most modern being a meridian instrument of Bessel (about 1800). In Mathematics his teachers were Rosanes from whom was acquired the first clear idea of mathematical infinity and the technique of matrix calculus which stood in such good stead, later on, for the development of quantum mechanics; and London, the father of F. London who is now well known to physicists by his work in collaboration with Heitler on the theory of valency.

And then at Heidelberg with Kœnigsberger, the biographer of Jacobi and Helmholtz. Kœnigsberger was an Anti-Kant and an Empiricist who even maintained that the formula $(a+b)^2 = a^2+2ab+b^2$ could be derived only from experience! The methods of differential geometry were acquired here and it was mentioned how these good old methods came in handy quite recently for the new field theory, when Weierstrass' results on minimal surfaces were suggested to Pryce in connection with his work on the two dimensional electrostatic case.

It was next at Zurich that he met for the first time a brilliant modern mathematician Hurwitz, a friend of Minkowski and Hilbert. Hurwitz, so well known by the "Hurwitz-Courant" of the yellow series of volumes, was a most inspiring lecturer too.

And at last Göttingen! Of whom else at Göttingen should he talk first if not of Hilbert who is, by common consent, the doyen of present-day mathematicians? Prof. Born spoke at length about his distinguished teacher, of his stimulating lectures, his mathematical work, his influence on his students and his personality. He recalled a hiking excursion to an old ruined town Plesse with Minkowski, Hilbert and Caratheodory during which he mustered sufficient courage to approach Hilbert and ask him why he studied Mathematics. The answer, so characteristic of Hilbert, was that he had chosen this subject because he had a bad memory! Hilbert's lectures in the class-room left the greatest impression

* Summary of a lecture delivered by Prof. Dr. Max Born before the Central College Mathematical Society, Bangalore, October 1935.

on his hearers and had the quality of everlasting stimulation. He would set out to devise in the class-room new and better proofs of theorems, invent new theorems and if unsuccessful return the next day with beautiful results which have been the admiration of the mathematical world. His mathematical activity could be classified into six periods: (1) Numbers, (2) Invariants, (3) Axioms of Geometry, (4) Integral Equations, (5) General Relativity and (6) Mathematical Logic. Hilbert laid the greatest stress on rigour and logical foundations and on the meaning of pure thinking independent of content. He was perhaps not endowed with the gift of physical insight commensurate with his genius in mathematics and he never felt quite happy in his relations with physicists as evidenced by his quarrel with Pringsheim. Talking about his personality Prof. Born called it strange and likened it to a crystal with sharp edges. People did not understand him. His thinking never went the smooth path of everybody's opinion, but was absolutely independent and unconventional. He had a sharp tongue and was not always what one would call a nice fellow, but he was faithful and good to his friends. He took great interest in politics where, as in everything else, he went his own way and liked to shock people by his opinions, which were always well founded. Even when he changed from extreme pacifism in which he believed during the war into a conservative attitude during the socialistic revolution, he had good reasons for doing so.

Talking next about Klein, the contrast between Hilbert and Klein was pointed out. Klein disliked in his lectures rigorous methods and preferred to give the constructive ideas of mathematics. Having undergone a breakdown in health on account of overwork in trying to keep ahead of Poincaré, he assumed the rôle of an educationist and took great interest in presiding over mathematical societies and in reforming methods of mathematical teaching. A very amusing incident was narrated of how Klein went on discussing, at one of the meetings of the Mathematical Society a Dutch book on "Flacke Krommen" and talked at length about the theory of surfaces until at last it was pointed by one of the audience that "Flacke Krommen" did not mean "Krumme Flächen" but "Ebene Kurven"!

Then came Minkowski who was attached to Hilbert in the most intimate friendship. Minkowski delivered brilliant lectures on Geometry and other topics. His actual original contributions to relativity have perhaps not been so far appreciated properly. It was during the seminars on electrodynamics conducted by Hilbert and Minkowski that the latter was developing his four-dimensional world theory when Einstein's paper appeared and it can be safely said that Minkowski's work was done quite independently. Prof. Born mentioned that his own first paper in Breslau was on relativity, *viz.*, on hyperbolic motion which caught Minkowski's notice who asked the author of the paper to be a lecturer at Göttingen.

Last but not least among the giants of Göttingen was the brilliant Carl Runge, the applied mathematician and spectroscopist, who it was
of. Born into modern physics.
ure of the mathematical life
ose days was the Thursday
afternoon walk of Klein, Hilbert, Minkowski and Runge. A separation of this company was effected by the sudden death of Minkowski from appendicitis and on this occasion Hilbert delivered his famous memorial speech on Minkowski. In this connection it is interesting to know that in Hilbert's estimation Cantor, Minkowski and Hadamard, three Jews, were among the first order mathematicians.

Minkowski's successor in Göttingen was Landau, well known for his brilliant work on the analytical theory of numbers and many other subjects.

Passing on next to his friends and colleagues, Prof. Born mentioned in the former category the names of E. Schmidt (Berlin) known for his work on integral equations and potential theory Caratheodory of real variables and variations, Zermelo of Mengenlehre, Herglotz, Max Abraham and others. When talking of Kœbe, an incident that happened at Rome when the International Mathematics Congress met there, was narrated of how when looking at the celebrated paintings of Michael Angelo in the Sixtina Chapel, Kœbe burst out on the ephemeral nature of works of art of this type as contrasted with his uniformisation theorems which would stand for all time! This was how he acquired his nickname of "Kunstmäcen." The other lecturers at Göttingen were Hermann Weyl famous for his group theory, Hecke, Tœplitz, Courant and Emmy Nœther, who has died recently in America. At her funeral Weyl said in his commemoration speech, that she is considered as the greatest woman mathematician known in the history of science, greater even than the famous Sonja Kowalewski.

The associations with Planck and Einstein at Berlin in war time were next touched upon. It was unfortunate that Einstein should have got mixed up in politics with his strong tendencies towards pacifism, liberal doctrines and socialism. This led to the unfortunate conflict with Lenard and Stark. Einstein's scientific work could be divided into two periods—the physical and the later mathematical period of which the first seems to be far more fruitful.

Talking in general terms, Prof. Born said that as a rule the physicists he had met were more "normal" and therefore less interesting than the mathematicians. An exception, however, was the case of Ehrenfest who was a strange character. He was a true cosmopolitan, born in Vienna, educated partly in Germany, thoroughly acclimatised in Russia, and at last Professor at Leiden in Holland. He was a man of intense feeling with a great capacity for pure and clear thinking. His house was bare without any furniture and a wall of it served as visitor's book whereon could be found the names of all great men who visited him! Freedom from tradition was a passion with him. He got his meals from public kitchens and never sent his children to school for their education. His Russian wife and his eldest daughter both were called Tatjana, but for distinguishing between them his friends used to style them (Tatjana) and (Tatjana)'! He died under tragic circumstances having committed suicide by shooting himself with a revolver; this fatal step was the result of a deep depression which overcame him very often when he found difficulties to keep step with the progress of the younger generation of theoretical physicists.

A rapid survey was then made of the foreign mathematicians and theoretical physicists whom he had met. In referring to Niels and Harald Bohr, he spoke of the former's great gift of physical intuition and likened him to a magician who, though not much of a mathematician, could grasp the physical aspect of a problem immediately. Amongst the Dutch scientists the palm was given to Lorentz, a great leader of scientific activity and the President of the Solvay Congress. Lorentz's lectures at Göttingen were then recalled. Reference was also made to Kramers, Ornstein and Brouwer. Brief mention was made of Poincaré, Hadamard, de Broglie and Brillouin in France, of Levi-Civita and Fermi in Italy, of Frenkel, Alexandrow and Fock in Russia, and of Moore, Birkhoff, Veblen, Wiener, Alexander, van Vleck (senior and junior) in America. Amongst the English mathematicians and physicists he had met, Prof. Born talked about Hardy, Littlewood, Darwin, Fowler and Dirac. About the silent Dirac, Professor at Cambridge, mention was made of the 'unit' invented by his friends, *viz.*, 1 Dirac = 1 word per hour !

In the last category of his pupils, Prof. Born spoke about Pauli, Heisenberg, Jordan, Hund, Dirac, Fermi and v. Neumann whose book on quantum mechanics was considered to go deepest into the subject. B. S. M.

What are Cosmic Rays ?

It is well known that X-Rays and the radiations emanating from the radioactive substances ionise air so that it becomes a conductor for the flow of electricity. It was found at the end of the nineteenth century that air possesses a residual ionisation (after all the contributions to ionisation from radioactive sources were taken into consideration or suppressed). This result did not seem surprising at first as the residual ionisation was attributed to the defects of the instruments or to the presence of minute quantities of radioactive substances, too minute to be detected. It was subsequently found that the phenomenon of the residual ionisation disappeared in deep mines, had an altitude effect and possessed many other peculiarities. Hess, Kolhorster, Bergwitz and Gockel found that the phenomenon depended on the altitude. Balloons provided with automatic arrangements for recording ionisation were used in the earlier experiments. In a recent flight, Piccard flew to a height of 16 kilometers and recorded an ionisation as great as 200 ions per c.c. per second in the upper atmosphere. These facts support the view that the residual ionisation is genuine.

The radiations emanating from radioactive substances responsible for the ionisation of the air are α-rays consisting of α-particles whose penetrating power is small, β-rays consisting of very high velocity electrons of a moderate penetrating power and γ-rays which are electromagnetic in nature with a very high frequency. It is natural to think that the primary radiation responsible for the residual ionisation of the atmosphere is due to some extreme form of either β-rays or γ-rays. There is one school of thought, led by Professor A. H. Compton, who interpret the residual ionisation as due to very high velocity electrons like those of the extreme form of β-rays, pouring like a rain on the earth from the outer space. There is another school of thought led by Professor R. A. Millikan, who hold the opinion that the primary radiation responsible for the residual ionisation is electromagnetic in nature like the extreme form of high frequency γ-rays. Apart from the divergence of the opinions held by the physicists, the phenomenon of the residual ionisation seems to be certainly connected with some processes occurring in the outer space or with causes not at all understood in Modern Physics. The radiations responsible for the residual ionisation of the atmosphere have been called the cosmic rays. It is important to realise that for observing the phenomenon, it is necessary to detect a very feeble ionisation of the air amounting in the average to a few ions, say 1 to 2 per c.c. per sec. at the sea level.

In 1929, Regener reported that the phenomenon of residual ionisation could be observed in Lake Constance even at depths of 750 feet below the surface and found that the relation between the intensity of ionisation and depth could be represented by an exponential function ; a similar relation also exists in the case of γ-rays. Regener considered that the primary radiation as in the case of γ-rays is electromagnetic in nature. This view has found support by the work of Millikan, and his collaborators. Millikan considers that practically all the residual ionisation is due to electrons (positive and negative) rather than to other heavier nuclei ; that about 80 to 90 per cent. of the ionisation is due to the secondary electron rays produced within the atmosphere by the incoming photons and electrons ; that there is no evidence that anywhere on the earth more than 2 per cent. of the ionisation found at sea level is due directly to the incoming electrons which is responsible for the latitude and the East-West variation of the intensity of the ionisation ; that the earth's magnetic field separates the incoming secondary electrons with low energy from those with high energy, allowing the former to concentrate near the poles and the latter, which have an excess of positive electrons, to concentrate at the equator and that the greater part of the ionisation of our atmosphere is due to photons with an energy of the order of 200 million electron-volts. In the year 1929, Bothe and Kolhorster, by employing a double Geiger counter arrangement so arranged that the ordinary radioactive radiations could not discharge both the counters simultaneously, adduced evidence to show that the cosmic rays consist of high velocity electrons. Bothe and Kolhorster found no variation of the intensity of ionisation with respect to the latitude between Hamburg and Spitzbergen, while Clay had found a decrease of the intensity of ionisation near the Equator in his geographic investigation of the cosmic ray intensity between Holland and Java. The extensive geographic study of the ionisation intensity organised by Professor A. H. Compton in several parts of the world have however shown that there is a genuine *geomagnetic* latitude effect, an East-

West effect and an altitude effect. These results can be very well interpreted according to the theory of the motion of electrons round a magnetic doublet (earth being considered as a magnetic doublet), a theory first enunciated by C. Stϕrmer of Norway, who interprets the origin and forms of *aurora-burealis* and the same theory has been extended by Lemaitre and Vallarta to interpret the asymmetric distribution of cosmic ray intensity on the basis of the corpuscular hypothesis. The investigations of the Italian school led by Rossi gave similar evidence for the existence of the asymmetry. Johnson's investigations on the distribution of the cosmic ray intensity support the corpuscular hypothesis and suggest that the corpuscles should consist exclusively of positrons. Clay has, recently, come to the conclusion that the primary radiation is of corpuscular nature, consisting of electrons, positive and negative, with energy 1-200 million electron-volts, and that this corpuscular radiation produces ultra-gamma photon radiations with energy 10^7–10^{10} *e*-volts. This produces secondary corpuscular radiation with 10^6–10^9 *e*-volts, which in turn produces gamma radiation with energy 10^8–10^7 *e*-volts, which finally produces the corpuscular radiation with energy amounting to 10^7 *e*-volts.

Skobelzyn, Anderson and their co-workers and also Blacket and Ochialini have obtained beautiful photographs of the showers of the corpuscular tracts in the Wilson Chamber. These showers are the paths of the secondary particles diverging generally from a point in the material enclosing the Chamber. Many other aspects of these showers have been examined by other investigators.

The question of the fluctuations in the intensity of cosmic radiation, has attracted a good deal of attention. In the year 1927, Hoffmann discovered the occurrence of sudden bursts of ionisation at certain times. This phenomenon was disputed by the workers of the Millikan school who attributed it to the discharge of the battery in the instrument employed for recording the ionisation. Swann and Compton have shown that Hoffmann's observation was not due to the battery, and more recently Hoffmann has shown that the phenomenon is genuine and is really fundamental. Dr. and Mrs. Montgomery investigated the dependence of the Hoffmann Strosse on the altitude and on the thickness of the material of the ionisation chamber. When the number of the ions are of the order $\cdot 5 \times 10$[illegible], the rate of occurrence of the bursts at Swarthmore (61 m.) was 0.4 per hour while it was 200 per hour at Pike's Peak (4300 m.). When the number of ions is greater, of the order 1.5×10[illegible] they found no appreciable difference in the frequency of occurrence between Swarthmore and Pike's Peak. They also found that the bursts increased with the thickness of the shielding. Thus this new kind of very penetrating radiation, coming in from outside, possesses many new and interesting properties.

N. S. N.

Academies and Societies.

Indian Academy of Sciences :

October 1935. SECTION A.— S. M. SHAH : *On Inequalities Satisfied by Certain Arithmetical Functions II.* D. D. KOSAMBI : *An Affine Calculus of Variations.* S. R. SAVUR : *A Simple Test of Value of a Particular Period in Forecasting.* S. BHAGAVANTAM : *Rotational Raman Scattering in Benzene.*—Results with a high dispersion spectrograph confirm those obtained hitherto with low dispersion instruments. The observations of Sirkar and Maiti are not confirmed. S. RAMA SWAMY : *X-Ray Analysis of the Structure of Iridescent Shells.—Part II.—The Haliotidæ.* —There is a preferred orientation of the *a* and *b* axes with a large error in the orientation. W. M. VAIDYA : *The Flame Spectra of Some Aromatic Compounds.*—The bands attributed to HCO are found to occur. The hypothesis of direct incorporation of the O_2 molecule explains the spectroscopic observations better than that of successive formation of hydroxyl groups. D. S. SUBBARAMAIYA : *Light Scattering in Gold Sols in Relation to Particle Size and Shape.*—In all the sols examined the shapes of the particles are far from being spherical. K. L. RAMASWAMY : *Dielectric Coefficients of Volatile Compounds of Fluorine and Boron.*—The moments of CF_4, NF_3, $(CF_3N)_2$, B_2H_6 and $B_3N_3H_6$ have been determined in the vapour state, and their structures discussed. BAWA KARTAR SINGH AND I. MAHANTI : *The Physical Identity of Enantiomers.—Part I.*—Rotatory dispersion of *l*-Borneol, enantiomeric camphors, camphoric acids, sodium camphorates, camphoric anhydrides, and camphorimides. S. CHOWLA : *A Remarkable Property of the "Singular Series" in Waring's Problem and Its Relation to Hypothesis K of Hardy and Littlewood.* T. A. VAHIDY AND K. C. PANDYA : *The Condensation of Aldehydes with Malonic Acid in the Presence of Organic Bases.—Part IV.* The Condensation of Piperonal. C. V. RAMAN AND N. S. NAGENDRA NATH : *The Diffraction of Light by High Frequency Sound Waves.—Part I.*—A theory of the phenomenon is developed and the calculations interpret the experimental results of Bär in a very gratifying manner. C. V. RAMAN & N. S. NAGENDRA NATH : *The Diffraction of Light by Sound Waves of High Frequency.—Part II.*— The new theory is extended to the case when the light beam is incident at an angle to the sound wave fronts. The results explain the variations of the intensity among the various orders noticed by Debye and Sears for changes in the angle of incidence.

October 1935. SECTION B.—K. RAMIAH AND S. RAMANUJAM : *Chlorophyll Deficiencies in Rice* (Oryza sativa).—Nine types of Mendelian chlorophyll deficiences consisting of both unicoloured and variegated forms have been described and their inheritance discussed. Some of these like the "zebra-marked," lutescent, and certain variegated forms are recorded for the first time in rice. N. L. SHARMA AND S. PURKAYASTHA : *The Heavy Minerals of the "Erinpura" Granite and Microgranite of Danta State (N. Gujrat).*—Twenty

specimens of granite and six of microgranite from the main exposures of the "Erinpura" rocks have been analysed from their heavy minerals. M. DAMODARAN AND M. SRINIVASAN: *Ascorbic Acid (Vitamin C) Content of Some Indian Plant Materials*.—The ascorbic acid contents of a number of indigenous plant materials have been tabulated. The Indian gooseberry gives the highest reducing value by the Tillmann-Harris technique among the materials examined (See *Curr. Sci.*, 1935, 3, 353). B. N. SINGH: *The Correlation between Life Duration and Respiratory Phenomena*.—The study of the respiratory index of short-lived and long-lived plants has revealed characteristic differences between the two classes of plants. In the short-lived plants, the index decreases for an early phase of the fourth cycle, the rate of fall becoming more pronounced before the initiation of the reproductive organs. In the long-lived plants, on the other hand, the rate is more or less steady and shows a stop only towards the end of the growth cycle. J. DAYAL: *Studies on the Trematode Parasites of Indian Fishes I*.—A New Trematode, *Monorchotrema taakree* n. sp. from a Fresh Water Fish, *Pseudeutropius taakree*, from Lucknow.—A trematode of the family Heterophyidæ found as an adult in the intestine of a fish (*Pseudeutropius taakree*) has been described. S. B. KAUSIK: *The Life-History of* Lobelia trigona *Roxb. with Special Reference to the Nutrition of the Embryo-Sac*.—The nutritive mechanism of the embryo-sac has been described.

University and Educational Intelligence.

Annamalai University:

1. *The Founder's Day*.—The Sixth Founder's Day was celebrated on the 12th October, 1935, under the presidency of the Right Hon'ble V. S. Srinivasa Sastri, P.C., C.H., LL.D., Vice-Chancellor of the University. Captain M. Abdul Hamid, M.A. (Oxon.), Principal, Government Mohammedan College, Madras, delivered the Address.

2. *Convocation*.—On the 31st October, 1935, the Fifth Convocation of the University for conferring degrees, diplomas and titles was held when His Excellency Lord Erskine, G.C.I.E., Governor of Madras and Chancellor of the University, presided. Sir Mirza M. Ismail, KT., O.B.E., Dewan of Mysore, delivered the Address to the graduates. 103 candidates were presented at the Convocation besides 41 who took their degrees and titles *in absentia*.

An ordinary meeting of the Senate was held on the same day at 3 P.M. The following resolutions moved by Mr. G. Srinivasa Ayyar were adopted :—

i. The Senate recommends that a Bureau of Information of careers for graduates be opened at the University to provide facilities for the employment of the graduates.

ii. The Senate resolves that an official register of the graduates of the University be maintained and revised every year to give particulars of their address, employment and achievements.

The Senate also approved of the proposal of the Syndicate to institute for a period of 3 years a teaching post in the grade of a lecturer for the Department of English, in view of the large number of students admitted this year and the additional work entailed thereby.

3. *Special Lectures*.—On the invitation by the Syndicate, the following persons delivered courses of special lectures during October, 1935;—

Dr. H. Parameswaran—3 lectures on "Vacuum Technology." Prof. P. Sambamurthy—4 lectures on "South Indian Music," with an Orchestral Concert on the 2nd November.

4. *Library*.—The University Library has been re-organised with a view to making it more useful to the staff and students. Provision has been made for a spacious reading-room and arrangements have been made for the Library to work from 7 A.M. to 7 P.M. on all days of the week including Sundays.

5. *Inter-Collegiate Debate*.—Under the auspices of the University Union, an inter-collegiate debate was held on the 19th October in which representatives of the Madras Colleges (Presidency, Christian, Pachaiyappah's and Loyola) participated. The subject of the debate was:

"That Science can achieve the moral well-being of humanity more effectively than religion."

Messrs. C. Jagannathachari of the Annamalai University and K. Rangachari of the Christian College, Madras, were adjudged the best speakers and awarded a prize each.

Under the auspices of the Sanskrit Society, M. R. Ry. K. Balasubrahmanya Ayyar Avl., B.A., B.L., Madras, delivered the Inaugural Address. The occasion was availed of to have the portrait of Mahamahopadhyaya Vidyavachaspati S. Kuppuswami Sastriar, M.A., I.E.S. (Retd.), Professor of Sanskrit and Comparative Philology, Presidency College, Madras, unveiled by the Vice-Chancellor.

6. *Talks on Popular Subjects*.—A system by which a member of the Staff gives a talk to the students every week or a fortnight on a subject of popular interest, was inaugurated in September last by the Vice-Chancellor.

The following members of the Staff gave talks on the following topics:

The Vice-Chancellor: on "The Italo-Abyssinian dispute."

Prof. M. S. Sundaram: on "The Far East."

Mr. V. R. Viramani: on "The Sanctions."

7. *Elections*.—The Elections to the several University authorities that are now being reconstituted are in progress and the new bodies will function from 6th December 1935.

Andhra University:

The following candidates have been qualified to receive the degrees noted below :—

Doctor of Philosophy: A. Veerabhadra Rao, M.A. Title of Thesis: "Studies on Raman Effect." I. V. Radhakrishna Rao. Title of Thesis: "Sirrhosis of the liver in Northern Circars."

Master of Science: Mr. D. S. N. Murti, B.A. Title of Thesis; "Isomerism in Organic Chemistry."

REVIEWS.

La Spectroscopie Appliquée. Par P. Swings. (Paris: Hermann et Cie, 1935). Pp. 188. Price 15 fr. Paper Cover.

The most important practical application of spectroscopy is to be found in the analysis of the chemical constitution of the source of radiation and has had spectacular success in giving information about the heavenly bodies. The more mundane question of the determination of the chemical constitution of different chemicals, alloys or minerals is no less successfully attacked by the methods of spectroscopy. Its greatest utility is due to the fact that constituents present in very minute quantities can be detected and the amount of the substance required for the analysis is also small. Local examination of intrusions in a metal, etc., is another domain where spectroscopic methods are supreme. Though qualitative analysis has been known to be a commonplace application for a long time, it is only recently that methods of quantitative analysis have been giving reliable results. Nowadays, however, many industrial laboratories employ spectro-analytical methods on account of their sensitiveness, rapidity and small demand on the amount of substance necessary. The book under review has been written by one who has made contributions to the study of band spectra. It is an admirable resumé of the methods of qualitative and quantitative spectro-analysis. The most recent researches have been taken into consideration and the practice made quite clear by definite instructions. The rationale of the methods, their advantages, fields of application and limits of error have been well discussed so that a careful choice of the most suitable technique in any case will be easy for any one who seriously studies the book. The discussions and instructions are always brief but clear and to the point. A number of tables not given in the book would be required in practice but the bibliography in the book makes it quite easy to find the required information. Applications to Biology and Medical Jurisprudence are touched upon and in the end a very brief summary of the theory underlying the unravelling of atomic and molecular spectra is given. With occasional reference to the larger treatises mentioned in the text, the volume will serve as an admirable handbook for the industrial spectroscopist.

T. S. S.

Optical Rotatory Power. By Professor T. Martin Lowry, C.B.E., M.A., D.Sc., F.R.S. (Text Books of Physical Chemistry.) (Longmans, Green & Co., Ltd. London, New York and Toronto.) 1935. Pp. xiii + 483. 30s. net.

Professor Lowry and all chemists interested in optical rotatory power are to be congratulated on the appearance of this excellent book. It is a landmark in the study of optical activity, and is a record of work and progress in polarimetry, extending over a period of 120 years, from the original discovery of the optical rotatory power of Quartz by Biot in Paris (1813) to the recent theoretical work of Max Born in Cambridge, which has at last provided an adequate physical basis for the interpretation of one of the most difficult of optical phenomena.

Part I, Historical and General, besides describing the pioneer work of Biot and Fresnel, includes the epoch-making researches of Pasteur on Molecular Dissymmetry as well as those of Le Bel and Van't Hoff, which provided a firm foundation for the Science of Stereochemistry. This section also records the work of Pope and Werner. On the physical side, an account is given of Biot's Law of Inverse Squares, with its subsequent modifications culminating in the well-known formula of Drude, which suffices to express the rotatory dispersion of transparent media of all kinds with remarkable precision. Cotton's discovery in absorbing optically-active media of the twin phenomena of circular dichroism and of anomalous rotatory dispersion is also included. One of the most important phenomena of optical activity, namely, the Asymmetric Synthesis is also treated. The successful experiments of Freudenberg, Kuhn and Braun in realising for the first time, the preparation of an optically active compound under the influence of circularly polarised light is dependent on the utilisation of Cotton's discovery of circular dichroism. Just as Wohler's synthesis of urea shook the belief in the old vital force theory of the preparation of organic compounds, so, by the artificial making of a one-sided optically active substance in excess, a further advance is made on the road linking organic with inorganic nature. The significance of these results is enormous: they show that in principle no vital force is necessary for the

production of optically active compounds and thus refute Japp's dictum that "the absolute origin of compounds of one-sided asymmetry to be found in the living world is a mystery as profound as the absolute origin of life itself." The section closes with an account of Magnetic Rotatory Power and its application to studies of the chemical constitution of organic compounds. It is to be regretted that a very important and puzzling phenomenon of optical activity, the Walden Inversion, is left out and it is hoped that this omission will be rectified in a second edition of the book.

Part II, Polarimetry, is a very complete record of the development of polarimetric apparatus for the measurement of rotatory dispersion in the visible, ultra-violet and in the infra-red regions of the spectrum. The last chapter in this section is devoted to the measurement of circular dichroism, the significance of which is already pointed out in the foregoing paragraph. This section will doubtless be found very useful to workers in this field of optical investigations.

Part III, Special Cases, records the application of polarimetric methods to the study of the following substances: quartz, amyl alcohol, *iso*-valeric acid, tartaric acid, malic acid, lactic acid, sugars, camphor, borneol, nicotine, and some of Werner's coloured co-ordination compounds. This section also treats of a number of important problems of general interest, *e.g.*, Hudson's "iso-rotation rules", the phenomenon of muta-rotation, discovered by Dubrunfaut in 1846, anomalous rotatory dispersion and circular dichroism. The author has drawn largely from data published by himself and his students.

Part IV, Theoretical Considerations, gives an account of optical rotatory power of crystals, "liquid crystals" and solutions. This section is, however, devoted mainly to recent work on rotatory dispersion in transparent and absorbing media with a view to express the magnitude of their optical activity by means of mathematical equations. Kuhn, Gray, de Mallemann and Boys have attempted to co-relate optical activity with other optical and chemical properties of a substance by using different methods. Boys finds a rather simple expression for the rotatory power, which contains nothing else but the refractivities and the effective radii of the chemical groups involved. This theory cannot explain the fact that a strong absorption band may make a very small contribution to the optical activity and *vice versa*. "The real theory of optical rotatory power may be found by the mathematician, but is concealed from the chemist, in the papers of Born" says Prof. Lowry, "who recognised that *four* coupled electrons are required to produce optical rotatory power." A survey of Born's theory is included.

The book is well printed and illustrated. The number of mistakes is indeed very small in a book which contains so much matter.

BAWA KARTAR SINGH.

Elementary Electricity and Magnetism. By N. Robert W. Hutchinson, M.Sc. (University Tutorial Press, Ltd., London.) Pp. 475. Price 6/6.

In this excellent volume Mr. Hutchinson has set forth with great lucidity the elements of Magnetism, Static and Current Electricity. Within less than 500 pages of large print, the author has provided a wealth of theoretical and practical information that will more than cover the average Intermediate syllabus in India. In addition—and this constitutes the greater value of the book—he has brought the matter right up to the minute almost, by including brief but simple and clear accounts of the latest developments, *in theory and practice*, of physical science. The student of science as well as the "man in the street" hears so much about these developments that his curiosity is naturally aroused. In this book he can learn a good bit about X-rays, Wireless, Atomic theory, Transmutation of the elements, Radio-activity and even Television!

There are innumerable text-books for those who desire to learn just what is needed for examination purposes but here is a work which must be read by all students—if only for the stimulation of that curiosity which has been the foundation of most great discoveries in the past.

P. A. M.

Notes on Organic Chemistry. By F. Francis, Ph.D., D.Sc., F.I.C. (E. Arnold & Co., London, 1935.) Pp. 518. Printed on one side. Price 12*s.* 6*d.*

These notes have been written for the advanced students in the Honours Schools with a fairly sound background of organic chemistry.

In the Introductory portion such diverse

subjects as Theories of Radicals, Concepts of Valency, Isomerism, Rise, Growth and Development of Stereochemistry, Strain Theory, Tautomerism, Applications of Physical Methods to problems of Organic Chemistry, etc., have been dealt with in the space of 42 pages printed on one side. One cannot help feeling that the treatment is cursory and the value of the work is greatly diminished by absence of references to the original papers of the authors cited. For example, the subject of Infra-red Spectroscopy is dismissed in five lines without any reference even to the outstanding papers on the subject. It is doubtful if such treatment would serve any purpose except in merely informing the reader that Infra-red Spectroscopy is one of the methods used in the determination of the configuration of the molecule. Similarly the important subject of dipole moments does not receive any better consideration.

The book is badly revised as numerous serious errors of formulation occur throughout. It is particularly noticeable in Chapter II where the formulæ on p. 66 under 27, on p. 82 under II, on p. 84 under 21 and under III, on p. 86 under 23 are but examples of many similar errors.

The reviewer had some difficulty in understanding the logic of the arrangement of the subjects. It seems that a mass of facts are grouped together without a definite plan. Perhaps some consolation is to be found in the fact that the book is intended to be nothing more than mere Notes—a *vade mecum* for an aspiring organic chemist.

The author has not often been successful in stimulating the interest of his readers. For example, under phenyl hydrazine (p. 496), the three reactions that appealed to him are (*a*) the indole condensation, (*b*) pyrazolone formation, and (*c*) reducing action of phenyl hydrazine. The indole condensation is dismissed with the statement, p. 498: "To a certain extent the reaction is general although its mechanism is not clear". No references, of course, are given to Robinson's work on the mechanism of indole formation or Reddelin's work.

Notwithstanding the defects, the book contains a lot of useful information which would be of help if the reader finds out the proper references himself and makes notes of them in the alternate blank pages provided.

The Chapter on additive reactions of unsaturated compounds gives a useful summary of the recent work on the subject.

One wishes "The Diene synthesis" had been a little more fully dealt with although the account given is excellent in many ways.

The book would be serviceable to the advanced students of chemistry. It is hoped that in the second edition the proofs would be better corrected and references to the original papers would be given where necessary.

J. N. R.

Introduction to Vertebrate Embryology. By Waldo Shumway, Ph.D. (John Wiley & Sons, Inc. New York, 1935.) Pp. xii+390. Price 20*s*. net.

The III edition of W. Shumway's *Introduction to Vertebrate Embryology*, is an addition to the literature in the field of Embryology. As the author rightly points out Embryology is not an easy subject, for the student must possess a capacity to imagine the changing conditions of the embryo and thus mentally reconstruct a three-dimensional picture of the embryo from stage to stage. The book is divided into five parts and each part contains a large number of chapters and each chapter concludes with a concise summary and a list of the more important reference papers. Part I, besides giving a brief account of the genesis of the study of Embryology, also describes the life histories of chordates like Amphioxus, Frog, Chick and Man in a very elementary way. The next two chapters deal with early Embryology and Organogeny. In Chapter IV on Chromosomes and Genes, brief descriptions are given of the Sex chromosomes, Linkage, Crossing over, Chromosomal aberrations, etc. Embryonic form and extra embryonic structures is the subject-matter of Chapter VI. How the form of the body is to a large extent governed by the shape of the gastrula as well as the extra embryonic structures is described. In describing the yolksac, it is said (p. 136) that "In other mammals (Fig. 68) the endoderm grows completely around the interior of the trophoblast and forms a larger yolk-sac." How about the yolksac in forms like Cavia where the distal wall is absent? It may be noted here that Fig. 6 refers to a sagittal section through early gastrula of pigeon. We feel that the author should have described in greater detail the formation of amnion in mammals and discussed the nature of the amniotic cavity in forms like guinea pig and Primates. On

p. 144 in a short paragraph on the "Allantois of man and other mammals," the author points out that "In most of the mammals there is a well-developed allantois, arising like that of the chick.... but the human allantois is rudimentary." A knowledge of comparative embryology tells us that no doubt the allantois arises as in chick and is well developed in mammals, but certainly as a rule in Primates (including man), it is rudimentary. A serious mistake is committed by the author in the paragraph on "The Placenta" (p. 145). It is said that "In Perameles (Fig. 93 B), an allantoic hemiplacenta is formed by the union of the allantoic sac with the trophoblast. Where this hemiplacenta touches the mucosa the epithelium of the latter thickens and is invaded by maternal capillaries. The trophoblast is said to be resorbed so that the capillaries of the allantois come into intimate connection with those of the uterus." When we say that the "epithelium of the latter thickens" it obviously gives us an idea that the cells increase in size and thickness, but really the cells become syncytial and again, the trophoblast is never resorbed, for it unites to form a large syncytial layer with the uterine mucosa. The next chapter on Experimental Embryology is interesting. The well-known rule that development is epigenetic is stressed ; and given a suitable inheritance of genes and a favourable environment, it is noted that development proceeds normally. Development ceases due to overdosage of Ultra-violet light, X-rays or radium emanations. A reference is also made to the works of Müller in describing the influence of agencies like X-rays, etc., on the rate of mutation of Drosophila genes. Part IV dealing with the anatomy of vertebrate embryos like Frog, Chick and Pig, assists the student in identifying parts easily. A good account of the various methods used in embryological studies for preparing slides by the ordinary and celloidin methods, reconstruction are clearly described in Part V. A glossary of nearly 15 pages is also given.

The get-up of the book is excellent and the book should find a place in the library of every embryologist.

R.

Forest Research in India, 1933-34. (Manager of Publications, Delhi.) Parts I and II.

A perusal of this booklet makes interesting reading both to the layman and to the scientist. Part I which deals with the Forest Research Institute, Dehra Dun, is of more general interest and gives one an insight into the progress being made from year to year in the more technical aspects of Forestry. Further advances are recorded in Silviculture, particularly with regard to Sal, in statistical methods, in Botany, Mycology and on the economic side.

The study of "Spike" in Sandal has reached a stage when certain definite results can be confidently expected and it is therefore all the more regrettable that the experiments have had to be closed down for lack of support from the Madras Government. Interesting and conclusive results have been reached with experiments in sleeper seasoning and stacking, and a new and improved method of kiln-seasoning has been perfected. In this connection it is interesting to note that Deodar sleepers in the Punjab are to be treated with a wood preservative before use while, on the other hand, the soft-wood sleeper treating plant in Assam has been closed down for lack of support from the Railways concerned ; this latter must mean a heavy blow to the marketing of the Upper Assam soft-woods. A heartening feature, however, is that soft-wood veneers from this area are gradually establishing themslves, particularly in the tea-trade. A notable achievement on the side of wood-preservation, has been the patenting by Dr. Kamesam of the "Ascu" process : a logical development of the Falkamesam process, by which both Arsenic and Copper are "fixed" in the wood. This will mean a considerable reduction in the cost of preservation with an increased degree of protection, although a supplementary impregnation with oil, to prevent splitting, will apparently be necessary. The technique for testing wood-preservatives has also been considerably improved upon marking a distinct advance on the old "graveyard" methods. Investigations into pulp-manufacture have also been continued with satisfactory results.

Turning to the Provinces, we find an extension in the Andamans of the new method of naturally regenerating mixed deciduous forests by removal of the cover from below upwards.

Assam is making steady progress in the regeneration of Sal, in spite of the inroads of Eupatorium and it is becoming increasingly the suspicion of some foresters there that the presence of grass is not absolutely necessary for the production of regeneration,

and that the latter would appear to be largely dependent on certain soil-factors. The working plan for the Evergreen forests of Upper Assam has been brought practically to a stand-still by the closure of the soft-wood sleeper-treating plant.

Bengal continues to experiment with the regeneration of Garjan (Dip. Spp.) and Sal; the latter continues to be the main problem in Bihar and Orissa and the U. P. In Burma stump-planting of teak and the influence of the origin of teak seed on growth and quality continue to demand attention, while in the C. P. the new systems of coppicing adopted in place of the selection and improvement systems have not produced entirely satisfactory results in the best teak forests. In Madras teak again is the species receiving most attention, and valuable results appear to have been obtained in planting and tending. In the Punjab Blue Pine regeneration continues to be difficult, while the Sal problem in the U. P. remains at a stand-still.

Coloured Plates of the Birds of Ceylon. By G. M. Henry. With a short description of each bird by W. E. Wait, C.M.G., M.A., F.Z.S., ETC. Part IV. 16 coloured plates. (Published by the Ceylon Government, 1935.) Price £1–10–0.

There is a Chinese proverb which says that a single picture is worth more than 10,000 words. Nowhere is its application truer than in the case of bird study in India, for one of our greatest handicaps is the paucity or almost complete lack of good illustrations of Indian birds. Not that we have a plethora of bird books; indeed the very opposite is the case, but without pictures bird books would be of little use to the beginner or the layman. Pictures to be really helpful must be coloured, and pictures to be coloured are necessarily costly, and to come back to our starting point in this vicious circle, it is the costliness of colour printing that has so retarded the publication of popular bird books in this country and acted as dead weight against the advancement of this fascinating study.

An effort has indeed been made in recent years to overcome this drawback, and the beautifully illustrated books on the Game Birds of the Indian Empire by Stuart Baker and the set of 5 wall charts depicting about 200 species of the common birds of this country, published at great expense and considerable financial risk by the Bombay Natural History Society, and the *Popular Handbook of Indian Birds* by Hugh Whistler are the foremost examples.

Under the circumstances these coloured plates of the Birds of Ceylon are more than welcome, and the Government of Ceylon is to be congratulated not only upon its enterprise in undertaking their publication, but also upon its discovery of an artist of the accomplishments of Mr. G. M. Henry, an assistant in the Colombo Museum. It is not every artist, however masterful he may be, who can give a pleasing, accurate and lifelike rendering of a bird unless he is at the same time a naturalist and thoroughly familiar with his subjects *in life*. Mr. Henry obviously combines in himself both these attributes, and the plates which are the result of this combination are a real pleasure to behold.

In artistic merit, Part IV which is now before us, fully maintains the high standard set by its predecessors. It contains 16 plates, seven of which depict Passerine species, the remaining nine illustrating various non-Passerine forms.

It is perhaps unfortunate that while illustrating both the male and the female of the Ceylon Red-vented Bulbul, a species in which the sexes do not differ at all in colouration, only the male of the Ceylon Magpie Robin should have been shown. In the Indian race of this bird the black upper parts of the male are ashy-brown in the female, while the black in his lower plumage is replaced in the female by ashy-grey. In the Ceylon race the female is darker both above and below and sometimes indeed so dark that the correct sex can only be determined by dissection. Normally, however, there is sufficient dimorphism to have justified an illustration. We notice that Mr. Wait has attempted to supply this deficiency in his letter-press.

Sundry minor defects of undue accentuation of certain colours or *vice versa* are more or less inevitable in printing of this kind—for example there is too much blue in the back of the female Orange Minivet—but on the whole the reproduction of the plates is commendable.

The short descriptions of the birds by Mr. W. E. Wait, to whose well-known *Manual of the Birds of Ceylon* these plates are meant to be supplementary, touch upon the salient points in the distribution and habits of each species, but in our opinion measurements given in inches and such irritating decimals as "0·7" for example, are an

anachronism that is thoroughly inexcusable in a modern work even of a popular-*cum*-scientific nature. We cannot help thinking that the present work suffers appreciably in scientific value from the adoption of the inch as the unit of measure rather than the more rational and universally accepted millimeter.

The ultimate scope of the work is unknown so we do not know how many further parts to expect. We can only hope, however, that we may still look forward to many more of Mr. Henry's beautiful drawings and that the Ceylon Government will continue its useful and munificent work of sponsoring a publication, which, by the very nature of its sumptuousness, they cannot perhaps look upon as likely to prove a financial success.

S. A. A.

Biochemical and Allied Research in India, 1934. (Published by the Society of Biological Chemists, India. Bangalore Press, 1935.) Pp. 107. Price Re. 1.

The Society of Biological Chemists, India, has just issued its annual publication *Biochemical and Allied Research in India, 1934*. At the moment, this publication is the only one of its kind in giving us, at least in part, a measure of the chemical research carried out annually in this country. We wish that other Societies will emulate this example in publishing such annual reports in other branches of chemistry as well. For this purpose, the birth of the National Institute of Sciences and the Indian Academy of Sciences is a very happy augury.

In the present publication, the fifth in its series, the reviews on different aspects of biochemistry, written presumably by experts in the field, are exhaustive without being critical. This tendency on the part of the reviewer to be complete has resulted in a repetition of themes. Thus the work on nutrition is dealt at length in three different sections, though there could be only one place for it. It is a little amusing to read about problems of fruit preservation being discussed in a section on animal husbandry. It was possible, as in the previous years, to have presented the matter more systematically. The publication afforded the best opportunity to the Society of Biological Chemists to have offered felicitations to its two sister-Societies—the Indian Society of Soil Science and the Indian Physiological Society—started during the year.

Despite the best endeavour on the part of the reviewers to include every reference, a few have escaped notice. Being at the mercy of the belated foreign chemical abstracts for getting at Indian work, the authors of the review could not have done better. But there can be no extenuating circumstance for certain flagrant omissions, as, for instance, of the publications of the Indian Lac Research Institute, Ranchi.

The section on Agricultural Chemistry, which could have started with acknowledgments to the Imperial Council of Agricultural Research for the researches sponsored by it during the year under review, rightly claims the largest space in the publication. The researches, discussed in this section, are those carried out in the various Government Agricultural Departments, including "quake-striken" Pusa, and in the Department of Biochemistry, Indian Institute of Science, Bangalore. A finding by the last-mentioned Department, of special interest to the farmer, is the value of oxidising agents as fertilisers, resulting in one instance in a phenomenal increase of one hundred per cent. in the yield of tomato. Whether this finding, now having only a cloistered virtue, is capable of wide application in agricultural practice, is a matter deserving the attention of some co-ordinating scientific body. On another page of this section is described the work of Dhar and co-workers on the photo-chemical transformations in the soil wrought by metallic oxides, facilitating the oxidation of the organic constituents of the soil. Whether this is the cause of the phenomenon, of which the fertilising value mentioned above is the effect, is a question that an inquiring reader of the review is tempted to ask its author.

As with agricultural chemistry, the work reported in other sections of the publication is that carried out mostly in the different Government Departments. These departmental researches, being planned to meet special needs, are necessarily limited in their scope. In relief, stands the section on "Enzymes". The pure biochemist will still miss in this avowedly biochemical review of India a chapter on general biochemistry devoted to problems of fundamental interest. It is hoped that such a section, with the facilities and workers available in the country, will form the most conspicuous feature of the coming publications.

A short sectional title on each page and a subject index at the end would have

greatly added to the usefulness of the publication.

M. SRINIVASAN.

The Indian Sugar Industry. Lecture delivered by B. C. Burt, C.I.E., M.B.E., B.SC., I.A.S., Expert Adviser, Imperial Council of Agricultural Research, Journal of the Royal Society of Arts, 1935, **83**, 919.

In a paper with the above title, B. C. Burt has traced briefly the development of sugar industry in India. The author has pointed out that India can be regarded as the original home of sugarcane and prior to the grant of fiscal protection to Indian sugar industry, India was still in the anomalous position of being at the same time the world's second largest grower of cane and one of the greatest importers of manufactured sugar. Within four years after protection the output of factory sugar increased enormously and it is expected to meet the whole of Indian demand shortly. Organised efforts at establishing the modern sugar industry in India date from the year 1910. The work of Mr. Moreland in arranging for a demonstrative miniature vacuum pan factory, the specific recommendations of the Board of Agriculture in India and the Government's prompt action on them have been outlined. The author then has surveyed the progress made since 1911 and has sketched the achievements of the Coimbatore cane breeding station [illegible] the guidance of Dr. Barber. The work [illegible] Indian Sugar Committee (1919–20) [illegible] contributions by Rao Bahadur [illegible] raman to our knowledge of cane [illegible] have been mentioned, the latter in [illegible] what great detail.

The rest of the paper is devoted [illegible] development after the year 192[illegible] formation of the Imperial Council of [illegible] cultural Research in 1929, the Tariff [illegible] enquiry and the grant of protection [illegible] are all briefly described.

The paper concludes with a mem[illegible] the effects of Bihar earthquake a[illegible] possible future of Indian Sugar In[illegible] followed by a critical discussion.

This paper on the whole is a good [illegible] of the historical development of [illegible] sugar industry in India but the auth[illegible] not touched some of the main p[illegible] confronting the future of the indust[illegible] has amply dealt with the progress [illegible] the agricultural side and describ[illegible] achievements of the Coimbatore [illegible] mental station in improving the raw ma[illegible] Besides the very important problem [illegible] material, the problem of utilising ec[illegible] cally the by-products of the in[illegible] especially molasses, is also looming [illegible] Topics of such vital interest must hav[illegible] dealt with in the paper.

G. G.

Forthcoming Events.

Lucknow University Special Lectures—Session 1935-36.

PROGRAMME.

*Nov. 16, at 6–30 P.M. Biology Theatre.
"Plant-Geographical Barriers." By Dr. B. Sahni, Professor of Botany and Dean.

*Nov. 23 and 24, at 6–30 P.M. Chemistry Theatre.
"Alchemy or the Artificial Transmutation of Elements." By Mr. M. Raman Nayar, Lecturer in Chemistry.

Dec. 7 and 8, at 6–30 P.M. Chemistry Theatre.
"Adsorption." By Dr. A. C. Chatterji, Lecturer in Chemistry.

*Dec. 13 and 14, at 6–30 P.M. Physics Theatre.
"Recent Advances in Wireless and Television." By Dr. Wali Mohammad, Professor of Physics.

*Dec. 21 and 22, at 6–30 P.M. Biology T[illegible]
"Studies in Indian Liverworts." By D[illegible] Pande, Demonstrator in Botany.

Jan. 4 and 5, 1936, at 6–30 P.M. Biology T[illegible]
"Numbers." By Mr. R. D. Misra, Le[illegible] Mathematics.

*Jan. 17 and 18, at 6–30 P.M. Biology T[illegible]
"The History of Helminthology." By [illegible] S. Thapar, Reader in Zoology.

Jan. 19, 20 and 21, at 6–30 P.M. Biology T[illegible]
"Various Theories of Integration." [illegible] Lakshmi Narain, Reader in Mathem[illegible]

*Jan. 25 and 26, at 6–30 P.M. Biology T[illegible]
"Cultural Variation in Fungi." By D[illegible] Das Gupta, Reader in Botany.

(*These Lectures will be Illustrated.)

Erratum.

Vol. IV, No. 4, October 1935.

Page 267, Line 24 under Spiral Structure of Chromosomes, *Read* "....the [illegible] stage the coils are fully stretched and during the later stage the threads divide."

1807-35—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Ba[illegible]

Current Science

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CONTENTS.

(*For contents see page 394*)

The Zoological Survey of India.

WE have read the triennial report of the Zoological Survey of India for the years 1932–35 with considerable interest. This document recently issued by the Director presents in a concise and readable form the principal activities in which the departmental officers were engaged during the period covered by the report, and also indicates how the curtailment of grants has affected the progress of investigations. The work of the Scientific Surveys and the knowledge which they advance deserve the attention of governments and also of the public in greater measure than is generally accorded to them. The researches which they undertake are always of great intrinsic importance and frequently of real practical interest, but almost invariably, the value of scientific investigations is neither understood nor appreciated. Scientific work in India suffers from lack of proper exponents who can interpret its significance and its bearing on the practical problems of life in the language of the people. Many of the discussions initiated in the Indian Legislative Chambers on important public affairs have a scientific background, and decisions reached have frequently no relation to the proper appreciation of the development and the progress of science in its application to practical ends. It is needless to observe that the intelligent understanding and discussion of many administrative problems necessitates a fairly comprehensive knowledge of the scientific principles involved in their theoretical and practical aspects, and in their bearing on economics and politics as well as on social and legislative measures.

One of the ways, in which the work of the Surveys can be brought prominently before the public, is to extend and co-ordinate the existing Scientific Surveys where such co-ordination is desirable, and to establish a Committee of Scientific Advice. If such a Committee is formed on a representative basis, it should accept the responsibility of promoting discussion in the Council Chambers of Federal India on scientific subjects in their application to economic policy and national well-being. It may be necessary to organise periodical addresses by scientific authorities to the principal political parties, and to assist government in all administrative measures and acts involving the application of modern scientific knowledge. An organisation occupying the

status and fulfilling the duties of the Parliamentary Science Committee in Great Britain is already overdue in India, and the sooner we establish a definite link between Science and Government on the one hand, and Science and Society on the other, the sooner shall we secure the orderly progress of knowledge and the continuous improvement of the economic and social condition of the country. One of the most important truths which the Committee will have to impress on the public and government will be that scientific departments differ in their spirit and character from the administrative branches, and that investigations in the former should proceed uninterrupted by the fluctuations of financial assistance. Our civilisation has progressed by the increasing exploitation of the resources of animate and inanimate nature, and the wealth of the world increases in proportion to such exploitation. The reason why the industrialists invest more money in scientific research when their income falls, is that they live in a competitive world. Starving the scientific departments virtually implies extinction of the industry concerned. But governments as producers of wealth have no competitors, and their attitude towards scientific research correspondingly differs. Like all industrial organisations, government ought to find it more profitable to stimulate the means of earning increased revenue through scientific research, than to resort to the hackneyed policy of enhancing taxes during the recurring periods of financial depression. It is this aspect of administrative policy that the Committee of Scientific Advice that we have proposed should inculcate in the mind of government and the public. Until the political parties realise the imperative necessity of the substitution of such a financial doctrine in the place of the one now pursued, Scientific Surveys are liable to inhibitions of grants.

In the opening paragraph of the report the Director of the Zoological Survey observes that, as a consequence of the scheme of retrenchment applied to his department, the field investigations by the officers were greatly restricted, important research activities curtailed and the staff reduced to a maintenance basis. However the achievements of the Survey during the period reported, form an impressive record comparable with any previous term not affected by financial stringency. This was rendered possible by the unstinted devotion to work already in progress, but there must, however, be a limit to the exertion of unrelieved energy and enthusiasm. The improvement in the financial position of the Government of India offers hope that the grants to the Zoological Survey will speedily be restored to the original scale, without which the arrears of work must continue to exist, and fresh investigations cannot be undertaken. That the work carried on in the Zoological Survey is of such importance as to be recognised abroad is evident from the fact that two of its officers, Dr. S. W. Kemp and Lt.-Col. R. B. Seymour Sewell, were selected to lead oceanographical expeditions sent out by Great Britain within the last ten years. The wealth of research material and the facilities for investigation of practically every species of problem available in the Survey attract Zoologists from foreign countries, besides large numbers of research workers from the Indian Universities and other scientific institutions.

The main feature of scientific progress is the close and steady co-operation between different groups of investigators, since the discoveries in any branch of science find ready application in apparently unrelated departments of knowledge. We have several research institutions in India equipped and maintained by government subsidies, and prevention of overlapping of effort and of duplication of expenditure is a problem worth consideration. In what directions and to what extent intimate co-operation can be secured so as to save expenditure, and to secure at the same time concentrated action, must be one of the duties of the Committee of Scientific Advice already suggested. There are several directions in which the economy of Government grant and of the effort of investigators could be effected. For instance quite a considerable volume of taxonomic work in entomology is done at the different agricultural and forest research institutions in India, and also under the auspices of the Medical Research Fund Association. It would be advantageous, and in certain respects even necessary, to centralise this department of enquiry, as far as possible, at a single institution possessing the requisite laboratory and library facilities, and adequate reserve collections for comparative study. The experience and knowledge of the officers of the Survey and of the members of the subordinate staff when co-ordinated with those working in other research institutes should prove an invaluable implement for the elucidation of problems in which field

work forms the basis of all entomological investigations. Extension of the Entomological Section of the Zoological Survey of India would appear to meet all the demands, provided it gains affiliation and co-ordination of the work carried on in the different centres in such fields of investigation as co-operation would advance. Similarly for the more intense ichthyological research in India, the Fish Section of the Zoological Survey of India could be strengthened to considerable advantage, to which the fisheries departments in the provinces might contribute their experience and knowledge. We are not thinking of the centralisation of research, but only examining the possible advantages of creating a central body where problems in economic zoology could be investigated from a broader and comparative standpoint, and in the elucidation of which the provincial research institutes could honourably cooperate. What we want is research *rapprochement*. This is gradually being established by the Zoological Survey in undertaking detailed investigation in connection with the shell fisheries in the Andamans and their economic exploitation ; the identification of the animals of economic importance from the medical or sanitary point of view for the Calcutta School of Tropical Medicine, the Forest Research Institute, Dehra Dun, the Imperial Institute of Veterinary Research, Muktesar ; the identification of the human and animal remains excavated at Harappa, Mohenjo-daro and other chalcolithic sites in Sind, and the anthropological work connected with the last Census operations. On account of retrenchment, the survey officers have been assigned work which ought to be properly entrusted to the members of subordinate staff, and if they are released from the routine business, they ought to be able to undertake considerably more useful investigations in addition to the legitimate duties connected with their respective office.

The Zoological Survey of India is entrusted with the care and maintenance of the zoological and ethnological galleries of the Museum which in their richness and variety have few parallels in the East. Lack of funds has affected this department quite as seriously as the other sections of the Survey. The official view of the Museum is that it is generally a place for the gratification of the eye, and the message of the exhibits is therefore permitted to remain sub-conscious. It is essentially an educational institution carefully devised for popular enlightenment. It is also a place of reference. Want of proper care and attention due to attenuated staff, and of periodical additions in a bright and attractive form which naturally implies expenditure of money, must rob this section of the Zoological Survey of its power to instruct the visitors and of its usefulness to research students. In 1933, the Director of Zoological Survey was able through the munificence of Dr. S. C. Law to organise an exhibit of storks in a replica of their natural surroundings, and other groups of animals can be exhibited similarly, provided sufficient funds are placed at the disposal of the authorities. In addition to increased grants from governments, the Museum of the Survey should have a large endowment without which further improvements become difficult. The Museum is a great national institution, the usefulness of which is capable of being extended by organising a series of popular lectures on scientific subjects. The presence of foreign scientists who visit the Zoological Survey may be utilised for supplementing the excellent resources which the institution already possesses for inaugurating the scheme of popular addresses in a manner similar to those organised by the Royal Institution of Science and Technology in South Kensington.

The Zoological Survey is now under the direction of Indian scientists and in spite of the limitations imposed by retrenchment, they completed several important pieces of research, and started a large number of interesting investigations during the period under review. It seems to us that in addition to laboratory and field investigations, special branches of research in experimental and economic zoology should be organised when funds become available. No institution in India has such material resources and wealth of experience and knowledge for organising these new departments, as are possessed by the officers of the Survey, and the value of the results of such enquiries for promoting the material prosperity of the country must manifestly be multitudinous. It is true that the work of the Survey is increasing far too rapidly to be handled by the existing staff, and we should be reluctant to make proposals likely to add to their burden. The Zoological Survey is already engaged in important economic problems, but nevertheless the field of investigation is capable of enlargement. Our knowledge of economic ornithology and mammalogy of India is imperfect, and there are gaps in our

information regarding economic pisciculture and entomology. From the triennial report of the Director, we understand that he has submitted to the Government of India proposals for the extension of the department and increase of grants, and, in considering these proposals, we have no doubt that the authorities, while Indianising the services, will also provide them with the necessary means of maintaining their high standard of efficiency and traditional reputation.

Control of Drugs in India.

THE menace of drug adulteration and of traffic in spurious drugs prevalent in India at the present time was the subject of an address by Lieut.-Col. R. N. Chopra, before the Calcutta Rotary Club last month. The speaker showed that the market in India was being flooded by unscrupulous traders with drugs and chemicals of defective strength and impure quality and that potent remedies such as sera, vaccines, gland products and compounds of arsenic and antimony were being freely sold to the public without their quality being tested. The practice was a great menace to the public health and called for prompt institution of efficient safeguards to ensure the quality and authenticity of medicinal preparations offered for sale to the public. There is no doubt that India is *par excellence* the dumping ground for every variety of quack medicines and adulterated drugs manufactured in all parts of the world and that her markets are glutted with useless and deleterious drugs sold by unqualified chemists who are themselves a public danger. That this state of affairs has been going on for some years is shown by the fact that in 1930 the Government of India appointed a small *ad hoc* committee under the chairmanship of Lieut.-Col. Chopra to explore and define the scope of the problem and to make recommendations. The committee started work in October 1930, toured all over India and received a large mass of varied and voluminous evidence both written and oral. It considered carefully and systematically all aspects of the question and in April 1931, made comprehensive and far-reaching recommendations. It is nearly five years since the committee completed its labours and made its report but no action has been taken by the Government and the speaker showed that the position has gone from bad to worse. There is no doubt that all classes of drugs, those belonging to the British Pharmacopœia, those not officially recognised by the pharmacopœia but known and approved medicines including the group of biological products such as sera, vaccines, preparations of animal glands, organometallic compounds, and lastly the group of patent, proprietary and secret remedies are all equally affected. Col. Chopra went into detail of how these different groups were affected and described what was the effect of the substitution of genuine medicinal products by rubbish, which, according to him, has now reached a very serious stage. In diseases such as pneumonia, diphtheria, etc., it may make all the difference to the life of the patient whether he is getting a drug of proper strength or an adulterated or useless preparation. In the case of the complicated organometallic compounds, if they are not properly prepared and tested and in a state of absolute purity, their use will be positively dangerous and fatalities may occur. In the case of biological products incalculable harm may follow the use of products which are improperly prepared or stored. The injection of faked insulin in cases of diabetic coma may lead to the death of the patient. Much harm may result from the use of patent and proprietary and secret medicines in negative as well as positive ways. A patent medicine might be injurious and cause direct harm as in the absence of control some of the constituents may be positively dangerous. Some medicines might have the effect of masking early symptoms of serious and grave diseases and, assuaging them for a short period result in delay of scientific diagnosis and treatment. Col. Chopra performed a public duty of prime importance in bringing to their notice the grave danger the people are running in the absence of control over medicinal preparations. He emphatically pointed out that the Government is morally bound to take steps to rectify the present state of affairs.

The remedy has been suggested by the Drugs Enquiry Committee. The scheme put up by that Commitee, which has been generally accepted as being sound and effective, consists of two parts, namely legislation and the machinery to collect and test drugs. As regards the first part, it is a matter of common knowledge that there is no enactment in the Indian legislature at the present time which aims directly at the

prevention of adulteration or which ensures conformity to proper standards of purity and strength. Although most of the provinces have some sort of legislation, this is generally ineffective; moreover to bring about effectiveness and uniformity of control the legislation should be central and for the country as a whole. This part of the scheme would not entail any monetary expenditure and there is no reason why it should not be proceeded with immediately. Even if mere enactment of legislation by itself is not effective, it will produce a considerable moral effect and in that way will serve as a deterrant. Besides, if this is done time will be saved in future when funds do become available as along with legislation for the control of drugs, legislation, for control of the profession of pharmacy, which in India is still unorganised, will have to be enacted, and consideration of all these and drafting of the bill will naturally take time. The scheme worked out by the Drugs Enquiry Committee for the organisation, registration and training of this profession though it might need a small preliminary expenditure should eventually be self-supporting.

As regards the machinery to test medicinal preparations, this consists of a well-equipped central laboratory with competent staff of experts in various branches as well as provincial laboratories working under the guidance of the central laboratory. This part of the scheme undoubtedly needs an initial outlay and recurring expenditure. In actual practice, however, it will not be necessary to start with the complete scheme as drawn up by the Drugs Enquiry Committee at once so that the expenditure will not be very large in the beginning. The full scheme will take 3–5 years to develop and it will only be necessary to make a modest beginning which will not necessitate very great expenditure. By the time the scheme matures, a certain amount of revenue will be coming in and there is no reason why eventually the scheme should not be self-supporting or very nearly so.

So far as the Provincial Governments are concerned the scheme will also not be very expensive, as alarmists have suggested that it will be. With very little extra expenditure, the existing provincial laboratories could be so strengthened as to undertake the ordinary testing of drugs for the purpose of control. For complicated drugs they will have the central laboratory to utilise. We have no doubt that addition of two or three trained men, with modest salaries, to the existing staff of the provincial laboratories will be all that is necessary to carry out the work which will fall on these laboratories for several years to come. So far as the provision for the inspecting staff is concerned, the Drugs Enquiry Committee preferred the appointment of special drug inspectors not attached to any particular department. If, however, the appointment of these whole-time inspectors is too expensive under the present state of finances, the work can, for some years to come, be entrusted to the inspectors of the Excise Department. Little or no extra remuneration need be given to these officers, while the scheme is maturing the work thrown on them will be very light indeed. Later, when the whole scheme matures and revenue begins to come in from registration, licensing and fees for testing drugs, separate inspectors may be appointed.

The important point emphasised in the Report of the Committee, with which we emphatically agree, is that in any scheme of control the Central Government as well as Provincial Governments must take part. No system of control in which the Provincial Governments do not take their due share along with the Central Government will be feasible, or workable so that the responsibility lies on the heads of both. Public health is a transferred subject and the local legislators will be lacking in their duty if they do not realise their responsibility regarding drug control and let things continue as they are at present.

Isolation and Properties of Pepsin and Trypsin.

By John H. Northrop.

(The Rockefeller Institute for Medical Research, Princeton, N. J.)

ONE of the most striking characteristics of living things is the rapidity and precision with which the chemical changes necessary for their existence are carried on. The process of digestion is a familiar example. Proteins are split in the stomach into much smaller compounds, and this process is continued in the small intestine. The final products are precisely those needed for the nutrition of the animal and are formed from proteins with little or no evolution of heat or expenditure of energy. The process cannot be duplicated without the aid of enzymes since chemical hydrolysis of proteins yields different products and in any case can be accomplished only by violent treatment and the expenditure of considerable energy. Similar examples of the efficiency of the reactions which take place in the animal could be multiplied indefinitely. It is now known that these specific accelerating effects which living cells exert on the reactions occurring within them and in their vicinity are due to the presence of minute amounts of some substances formed by the living cell which have come to be known as enzymes. Without enzymes life could not exist and yet enzymes themselves are not living.

For many years this characteristic ability of living matter to direct these reactions was regarded as a vital activity entirely outside the realm of experimental science. Evidence gradually accumulated, however, to show that the living cell was not necessary, for some, at least, of these characteristic reactions: and one case after another was found in which the reaction could be made to take place without the living cell. But it was not generally admitted that only the enzyme was essential rather than the living cell itself until Buchner discovered that fermentation of sugar could be caused by yeast extract containing no living cells.

It had been suspected long before Buchner that the process of gastric digestion was due to the presence of some specific substance. Schwann in 1836 definitely assumed the existence of such a substance and named it "pepsin". The existence of trypsin in the intestine had also been suspected early in the nineteenth century, but was not definitely assumed to exist until the time of Corvisart (1857) and of Kühne (1867), who gave it its present name. A large number of other enzymes were then discovered by means of their characteristic reactions. It was assumed that since the reactions occur, enzymes must exist to cause them, but there was no direct proof of the actual existence of enzymes, and, in fact, their existence as ordinary chemical compounds has been frequently questioned. The problem is analogous to that of the causative agent of an infectious disease. A causative agent is assumed to exist because the disease occurs, but the assumption cannot be proved until the etiological factor is actually isolated.

During the time enzymatic processes were being discovered the chemists found that many purely chemical reactions are accelerated by small amounts of substances which apparently are not changed by the reaction. Berzelius pointed out that the properties of these substances are strikingly similar to those of the active agents found in living cells. He named the general phenomenon catalysis and considered what are now called enzymes to be a special class of catalysts.

The name "enzyme" was proposed by Kühne for these organic catalysts. In the last fifty years enzymes and enzymatic reactions have been studied intensively by chemists and physiologists. The chemists have been interested primarily in the mechanism of the reactions and the physiologists in the nature of the reactions, and both chemists and physiologists have spent a great deal of time trying to isolate the enzymes. Rapid progress was made in the study of the nature of the reactions caused by enzymes and in many cases the kinetics of the reactions were found to agree with chemical theory but the nature of the enzymes themselves remained quite unknown for many years.

In the last nine years the chemical nature of several enzymes has been determined; urease (Summer), pepsin (Northrop), trypsin (Northrop and Kunitz), amylase (Caldwell, Booker and Sherman), chymo-trypsin (Kunitz and Northrop), yellow respiratory ferment (Warburg and Theorell) and carboxy polypeptidase (Anson) have been obtained in crystalline form. These preparations are all proteins, and this result agrees with

much of the earlier indirect evidence concerning the nature of enzymes. The general chemical nature of these enzymes is therefore known. Enzymes have powerful catalytic properties, however, not possessed by ordinary proteins and hence must possess characteristic chemical structures not found in ordinary proteins. This characteristic chemical structure must be determined before the enzyme problem is completely solved.

ISOLATION AND CRYSTALLIZATION OF PEPSIN.

Nearly all attempts to isolate enzymes have been carried out with relatively small quantities of material in rather dilute solution. Adsorption methods have been extensively used. If enzymes really are proteins, these are not favourable procedures for their isolation, since proteins are extremely unstable in dilute solution and are easily injured by adsorption on surfaces. The attempt to isolate pepsin was undertaken from the point of view of protein chemistry using only those conditions under which proteins are relatively stable, *i.e.*, in concentrated solutions and at low temperature. Purification was accomplished by precipitation with ammonium or magnesium sulphate at various hydrogen ion concentrations and temperatures.

The method was based originally on that of Pekelharing who had described the isolation from gastric juice of an amorphous protein which had powerful proteolytic activity. The last step in Pekelharing's preparation consisted in dialysing a protein fraction from gastric juice against dilute acid. Under these conditions a white precipitate is formed which is a protein and which contains most of the activity. This protein sometimes appears in a somewhat granular form and under the microscope looks as though it might be trying to crystallize. Many attempts were made to crystallize the protein without success. It was noticed finally that this precipitate dissolved if the suspension were warmed to 37° C. and reappeared again upon cooling. These are good conditions for the formation of crystals, and the experiment was repeated under varying conditions and especially with more concentrated solutions, since crystallization in general occurs more readily from concentrated than from dilute solutions. A more concentrated suspension than usual was warmed to 37° C., and the solution was allowed to cool slowly to room temperature in a beaker. The next morning it was found to contain several grams of beautifully formed crystals in the form of double, six-sided pyramids. They were tested for activity and found to be highly active and also to be protein (Fig. 1).

Fig. 1.
Pepsin.

Only small amounts of the crystalline material could be obtained by the original method, but it was found possible to modify it and eventually to dispense with the dialysis which is the most troublesome part of the method. The crystalline protein can now be prepared from commercial pepsin preparations simply by precipitation with magnesium sulphate and then with dilute sulphuric acid. The protein crystallizes very readily, in fact much more readily than most proteins and it is easily possible to prepare 100 gm. in 2 days. A method is therefore at hand by which large quantities of a crystalline protein having powerful proteolytic activity can be prepared. The crystalline enzyme has also been prepared from bovine gastric juice (Northrop). Pepsin prepared from bovine gastric juice differs from, but is very similar to, that from pig gastric extracts. The two enzymes may be distinguished by solubility measurements. It is probable, therefore, that the various pepsins differ from species to species, as do the hemoglobins.

ISOLATION OF CRYSTALLINE TRYPSIN FROM ACTIVE PANCREATIC EXTRACTS.
(Northrop and Kunitz.)

Kühne considered that one enzyme of

the pancreas could hydrolyse protein completely to amino acids and called this hypothetical enzyme "trypsin". He showed that the pancreatic juice itself was inactive and only became active on reaching the intestine. The inactive form of the enzyme was named "trypsinogen". It is now known that the complete hydrolysis of proteins is due to a group of enzymes [erepsin (Cohnheim), amino-polypeptidase, carboxypolypeptidase, protaminase and probably others] so that the original "trypsin" does not exist. The name, however, has always been associated more especially with the enzyme which is activated by intestinal extract and digests proteins (Schepowalnikow). The name "trypsin" has been retained, therefore, to designate what appears to be the most important proteolytic enzyme of the pancreatic juice. This enzyme is present in fresh pancreas in an inactive form, trypsinogen, which is transformed into trypsin by intestinal extract or by allowing the pancreas to stand in slightly acid solution.

The methods used in the isolation of trypsin were, in general, similar to those used in the isolation of pepsin. The raw material was obtained by allowing frozen pancreas to thaw and collecting the expressed fluid. This fluid contained the active form of the enzyme. The problem of purification turned out to be a difficult one, and a great deal of work was done before any encouraging results in the way of either a crystalline product or a product of constant activity was obtained. The most promising method seemed to be precipitation with ammonium sulphate. A protein fraction was eventually obtained which had constant activity and gave some indication of crystallization. The work was made difficult by the very unstable nature of the protein. This unfortunate property made it impossible to allow a solution to stand for more than a few hours, so that the usual procedure for crystallization, which consists in allowing a solution to concentrate or cool very slowly, could not be used. After a large number of unsuccessful attempts, Dr. Kunitz was able to secure definite, regular crystals by the very cautious addition of strong ammonium sulphate to rather concentrated solutions of the protein. The crystals are rather small and are of the cubic system. The proof that this material is a pure substance is still more difficult than in the case of pepsin, since it is more unstable.

Isolation of Chymo-Trypsinogen, Chymo-Trypsin, Trypsinogen and Trypsin from Inactive Pancreas.

The method of isolation described above was laborious and somewhat uncertain since preparations were occasionally obtained which could not be crystallized. It seemed probable that trypsinogen, the inactive form in which the enzyme exists in fresh pancreas, was more stable and hence more easily handled than the active trypsin. The attempt was therefore made to isolate this inactive form of trypsin from fresh pancreas. It was found in the earlier trypsin experiments that the enzyme was remarkably resistant to acid while much of the other protein material present in pancreatic extracts was denatured by acid. Fresh pancreas was, therefore, extracted with strong acid and it was found that most of the inert material remained insoluble while the enzyme was dissolved and extracted. Extraction with strong acid yields a solution which is much more easily purified than those obtained with glycerin, bicarbonate or after autolysis. These latter methods are the ones which have been used in other attempts to isolate trypsin. The results obtained in the present work are largely due to the use of acid extracts. This extract remains inactive indefinitely but is rapidly activated by extract of small intestine (enterokinase) at pH 8·0.

Isolation of chymo-trypsinogen and chymo-trypsin.—The acid extract was fractionally precipitated by ammonium sulphate and a crystalline protein obtained from the fraction precipitated by 0·7 saturated ammonium sulphate (Fig. 2). This protein had no enzymatic activity and could not be activated by kinase. It was considered at first to be merely an inert protein but it was soon found that traces of trypsin would convert the protein into a powerful proteolytic enzyme which differed from the usual trypsin preparation in that it clotted milk. This enzyme probably represents Vernon's "pancreatic rennet" and was called "chymo-trypsin". This active form of the enzyme was also crystallized (Fig. 3).

Isolation of trypsinogen and trypsin.—The mother liquor from the chymo-trypsinogen still becomes active upon the addition of kinase or upon the addition of strong magnesium or ammonium sulphate to a neutral solution, and so still contains

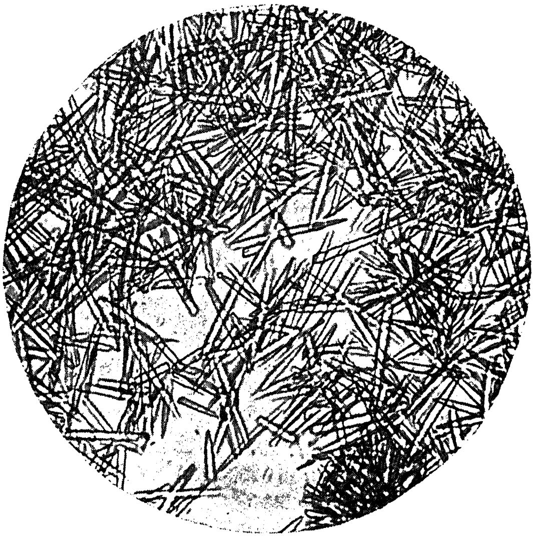

Fig. 2.
Chymo-trypsinogen.

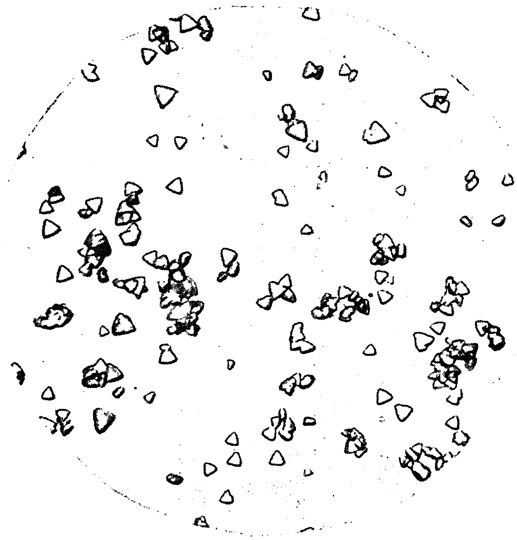

Fig. 4.
Trypsinogen.

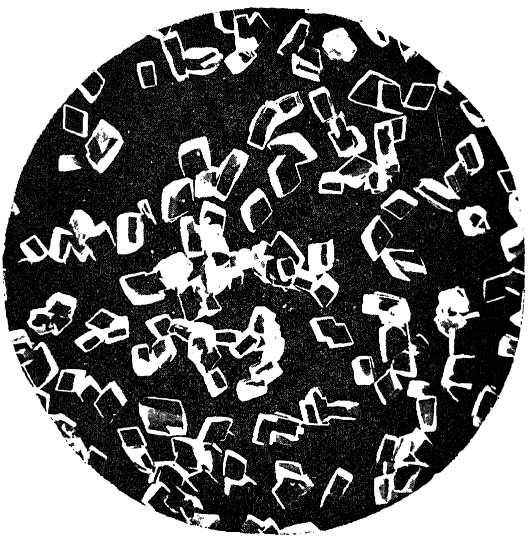

Fig. 3.
Chymo-trypsin.

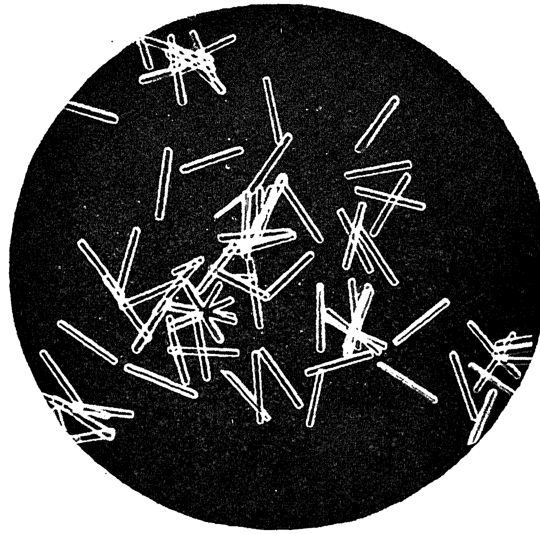

Fig. 5.
Trypsin.

inactive trypsin. The inactive trypsin (trypsinogen) was crystallized from magnesium sulphate solution pH 8·0 at 6° C. in the form of short triangular prisms (Fig. 4). Recrystallization was undertaken and appeared to proceed normally but upon examination the crystals were found to be long square prisms instead of triangular prisms and to be active instead of inactive (Fig. 5). They resembled slightly the crystals of trypsin previously prepared from active material and turned out to be identical with this earlier preparation. Material prepared by the earlier method also crystallizes in the same long square prisms under these conditions.

The transformation of the inactive form of the enzyme during recrystallization is due to the fact that the conditions for crystallization are the same as those for activation. Also, the crystallized trypsinogen activates much more rapidly than does the crude product. This peculiarity is

discussed later in connection with the mechanism of activation.

ISOLATION AND CRYSTALLIZATION OF CARBOXYPOLYPEPTIDASE.

Active pancreatic extracts contain an enzyme which splits certain amino acid compounds in such a way as to liberate an amino acid which, in the intact compound, has a free carboxyl group. This enzyme was named carboxypolypeptidase by Waldschmidt-Leitz. Anson has recently isolated and crystallized this enzyme from active pancreatic extracts (Fig. 6). The enzyme

Fig. 6.
Carboxypolypeptidase.

is a globulin and may be recrystallized without change in activity or other properties. It acts in the presence of strong formaldehyde and differs in this respect from the other proteolytic enzymes of the pancreas.

EVIDENCE THAT THE ACTIVITY IS A PROPERTY OF THE PROTEIN MOLECULE.

Tests of purity.—The experiments just described show that crystalline proteins having intense proteolytic activity may be isolated from gastric or pancreatic extracts. It is an experimental fact that these preparations are crystalline proteins but it by no means follows directly that the enzymatic activity is a property of the protein molecule. If it could be shown that the preparations are pure substances it would, of course, follow that the activity must be due to the protein but it is unfortunately extremely difficult to prove the purity of proteins. The usual criterion of purity is constant composition and properties after repeated crystallization and these preparations fulfil that criterion. Solubility measurements furnish one of the most sensitive tests for mixtures and careful solubility measurements were done with crystalline pepsin. The results showed no evidence of more than one chemical compound. Diffusion experiments showed that the rate of diffusion of the active molecule was exactly the same as that of the protein, proving that the two molecules must be the same size at any rate, if not identical. If an inert protein, such as edestin, is stirred in a solution of pepsin the enzymatic activity is taken up by the foreign protein and at the same time an exactly equivalent amount of pepsin protein is taken up. Pepsin, trypsin and chymo-trypsin, under certain conditions, are transformed into denatured, insoluble proteins. At the same time there is a corresponding loss in activity. The denatured protein may be changed back to the native, soluble form and when this is done the activity returns. If the proteins are denatured by ultra-violet light there is also a corresponding loss in activity and the wave-length which is most efficient in denaturing the protein is also the most efficient one in destroying the activity (Gates).

Trypsin may be digested by pepsin and in this case again the loss in tryptic activity is just proportional to the amount of trypsin protein hydrolysed. The same experiment may be performed with chymo-trypsin and pepsin or with pepsin alone in strong acid solution. The foregoing experiments indicate strongly that these crystalline proteins possess enzymatic activity and the next problem is to determine what particular chemical structure in the protein is responsible for this remarkable property.

Acetylation of pepsin (Herriott) has furnished some evidence in this connection. A crystalline acetyl derivative was isolated which contains 3 or 4 acetyl groups attached to the primary amino groups (Fig. 7). This derivative has the same activity as the original pepsin. A second crystalline derivative containing 7 acetyl groups has also been isolated (Fig. 8). It has 60 per cent. of the activity of the original pepsin. The four additional acetyl groups which decrease the activity are probably attached to the hydroxyl group of tyrosine.

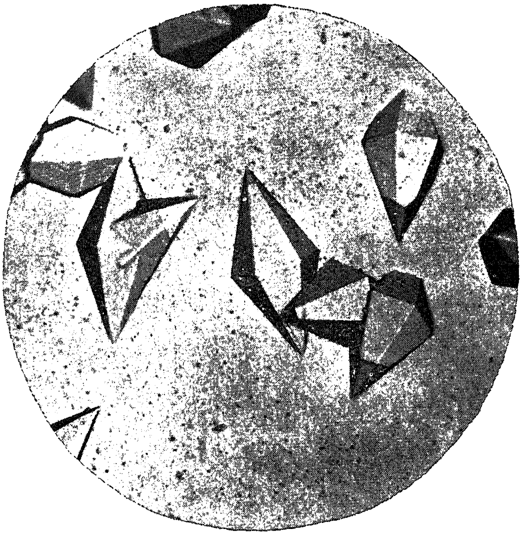

Fig. 7.
Four acetyl (100 per cent. active) pepsin.

Fig. 9.
Inhibitor-trypsin compound.

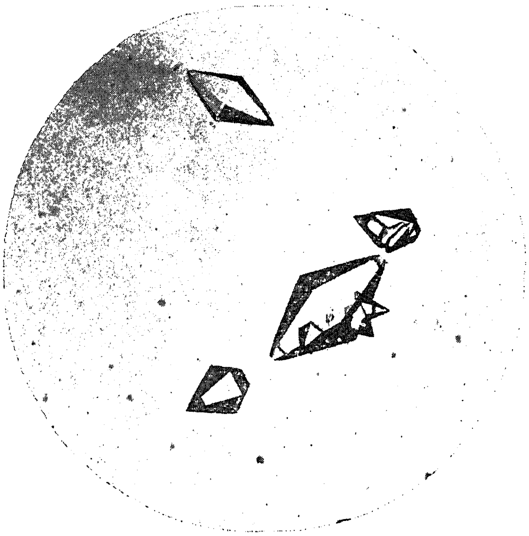

Fig. 8.
60 per cent. active acetyl pepsin.

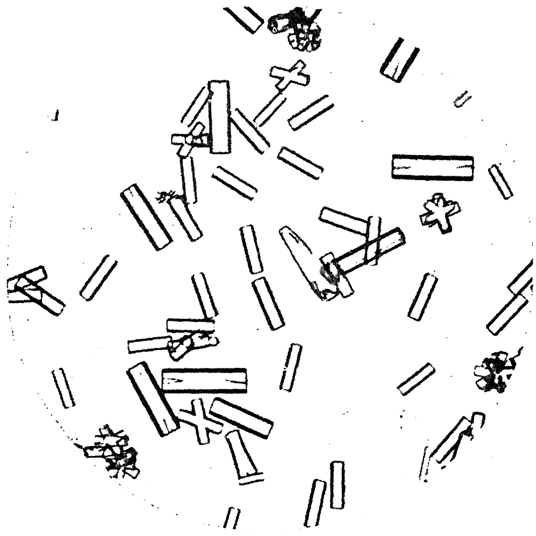

Fig. 10.
Inhibitor.

Evidently, therefore, the primary amino groups, which are presumably on the lycine, have no connection with the structure responsible for the activity, whereas the tyrosine is closely connected with the essential structure.

ACTIVATION OF TRYPSINOGEN.

Kühne and Heidenhain showed that fresh pancreatic juice has no proteolytic activity and only becomes active when mixed with a secretion of the small intestine. Vernon claimed that under certain conditions the activation was caused by trypsin itself, *i.e.*, the activation was autocatalytic, but this conclusion was denied by most subsequent workers. Isolation of the inactive form of trypsin has made possible a study of its activation. It has been found that in neutral solution the reaction is quite strictly autocatalytic, *i.e.*, the transformation of trypsinogen to trypsin is caused by the presence of trypsin itself. Trypsin, therefore, is an example of a molecule which may b

propagated since the inoculation of a solution of trypsinogen with trypsin gives rise to a very large quantity of trypsin and this process may be repeated indefinitely. In the crude extract this reaction is prevented by the presence of a substance which inhibits trypsin activity. A compound of this inhibitor and trypsin has been isolated and crystallized (Fig. 9). It may be separated into its constituents by treatment with trichloracetic acid. The trypsin precipitates and the inhibitor may be crystallized from the trichloracetic acid solution (Fig. 10). It has the general properties of a peptone and a molecular weight of about 6,000.[1]

[1] Summary of a paper presented before The Harvey Society, New York City, May 16, 1935.

Locust Research in Nigeria.

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INTRODUCTION.

BEFORE describing the locust research carried out by the entomological section of the Agricultural Department during the last five and a half years, it is necessary to give a brief account of the various species of locusts which occur in Nigeria.

Swarms of the Tropical Migratory Locust, *Locusta migratoria migratorioides*, R. and F., entered the south-western corner of Nigeria in December 1929, and had reached the Northern frontier by April 1930. Swarms have been present in this country ever since the original invasion and, each year, there have been two generations of hoppers.

In July 1930, hopper bands of the Red Locust, *Nomadacris septemfasciata*, Serv., were discovered near Lake Chad. Only one adult swarm has been found at a distance of more than about 12 miles from the lake.

Swarms of the Desert Locust, *Schistocerca gregaria*, Forsk., were present in that part of Nigeria lying to the north of the 12th parallel N. in April and May 1931; but, there is no evidence that *Schistocerca* either bred or caused damage to crops.

Occasional swarms of the Tree Locust, *Anacridium moestum melanorhodon*, Walk., have been reported from the north-western corner of Nigeria; but this species was not responsible for any damage to crops.

EXPLORATION OF SUSPECTED OUTBREAK CENTRES.

In June 1929, an elephant-hunter saw swarms of an unidentified species of locust migrating south-westwards to the central portion of the Nigerian shore of Lake Chad. These swarms settled and bred in this area. The presence of locusts in the Chad area some six months before the main invasion occurred led to Chad being regarded as a possible outbreak centre of *Locusta*. The discovery of numerous bands of *Nomadacris* hoppers in the southern half of Nigerian Chad in 1930 was the first record of the mass occurrence of the Red Locust in West Africa. As there was no evidence that swarms had migrated to Chad from the outbreak centre south of the equator it seemed probable that the bands were derived from solitary individuals locally.

In October and November, 1931, a preliminary survey was made of the shores of Nigerian Chad. It was found that *Nomadacris* was confined to the southern half of the shore and was associated with a tall grass, *Cymbopogon giganteus*, Chiov., which is absent from the northern part of the lake shore. *Locusta* adults of phases *solitaria* and *transiens* (*dissocians*) were found near the northern frontier and in the southern part of the shore. In June and July each year, *Locusta* swarms arrive from the south-west and breed in the Chad area, so it was impossible to say whether the solitary adults were derived from hoppers surviving the anti-hopper campaigns of 1930 and 1931 or, were the descendants of a permanent *solitaria* population. During the survey a site for a laboratory was selected at Kalkala near the south-western corner of the lake.

During the first six months of 1933 an ecological survey was made of the twelve square miles surrounding Kalkala. From January to April, the *Nomadacris* adults remained in *Cymbopogon* and other tall grasses. Shortly before the rains began in mid-May they commenced to spread from the tall grass areas into short grass and open farmland. Copulation was first

observed on June 20th. Phases *solitaria* and *transiens* (*dissocians*) of *Locusta* were present until mid-March though the number of individuals of both was small. From mid-March to the end of May only *solitaria* was present. Burning and grazing of the grass continually disturbed the locusts which were almost annihilated by Carmine Bee-eaters (*Merops nubicus nubicus*).

It was concluded that the Chad area is unlikely to be an outbreak centre of *Locusta* and that it was probable that conditions there are unsuitable for the production of the gregarious phase of *Nomadacris*.

The ecological survey at Kalkala was continued from September 1933, to January 1934, and from May to October 1934. In addition, a survey was made of a large section of the northern shore which had not been examined in 1931. As a result of this work it was concluded that the region from Kalkala eastwards to the French Cameroun frontier was probably merely the western fringe of a potential outbreak centre of *Nomadacris*. The Red Locust was found to absent from the northern half of British Chad and it was considered that conditions were unfavourable in that part of the southern shore lying to the north of Kalkala. Breeding began on June 1st, 1934, and oviposition was observed on the 16th of that month. As a result of a drought from mid-June to mid-July few hoppers emerged, and the Red Locust reverted to the solitary phase in the Chad area.

An interesting feature of this study was the discovery of *Nomadacris* adults in late October 1934, in areas some 30 miles to the south of the lake.

In May 1935, an entomologist was attached to a French locust mission and the southern shore of Chad was explored from the French Cameroun frontier eastwards to the south-east corner of the lake. Not a single specimen of *Nomadacris* was seen and the wooded character of this part of the shore makes it highly improbable that it is an outbreak centre of the Red Locust. At the conclusion of this work, a visit was paid to Kalkala and it was found that the solitary phase of *Nomadacris* has now become extremely rare in that district. It is possible that the energetic locust campaigns of 1930 and 1931, when about 20 Europeans were engaged in control work in the Chad area, prevented *Nomadacris* from attaining the swarming phase.

From April to September 1932, an entomologist explored the outbreak centre of *Locusta* in the Middle Niger region of French Soudan. The results of this work have not yet been published. The area was subsequently examined by a French locust mission.

FUTURE RESEARCH WORK.

In the near future it is proposed to examine certain marshes in the Bornu and Adamawa Provinces in order to determine the range of *Nomadacris* in Nigeria. It is possible that one or more of these marshes may prove to be a potential outbreak centre.

Every year it is proposed to visit the Chad area with the object of observing the *Nomadacris* population and of organising an anti-hopper campaign should there be any sign of transition from the solitary to the gregarious phase. After *Locusta* has reverted to the solitary phase, these annual visits will afford an opportunity of determining whether this species exists in the Chad area during the intervals between outbreaks.

THE EFFECT OF CLIMATE ON MIGRATION AND BREEDING.

Monthly maps showing the movements of *Locusta* swarms in Nigeria have been prepared since the beginning of the infestation in 1929. The swarm movements are studied in conjunction with climatic factors. As a result of such a study (for the first 17 months of the infestation) an entomologist concluded that with very few exceptions, swarms remain where the mean relative humidity (9 a.m., L.M.T.) is not more than 85% and not less than 40%. This worker also studied the effect of climate upon breeding and concluded that breeding does not commence after the dry season until the humidity rises to 65% and the degree of wetness (total monthly rainfall $\times$ number of days on which rain fell $\div$ 10) reaches 2.

A similar study is now being made of the data available for the first five years of the infestation.

Other branches of research are the biometrical study of adult locusts and the testing of various poisoned baits for use against hopper bands.

Quality in Foods.

By A. Sreenivasan, M.A.,
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IT has long been recognised that agricultural products can be characterised by certain properties which can be collectively described as quality. In some cases the quality can be defined in terms of certain physical characters such as size, shape, colour or behaviour on milling or cooking. In others, it depends largely on properties such as taste and flavour which are rather difficult to define but are, nevertheless, quite real. In recent years there has also been increasing realization of the importance of constituents such as, vitamins, proteins, calcium and phosphorus which are so essential to nutrition and, in consequence, are of great value in assessing the quality of food. As articles possessing the right quality are in great demand and fetch good prices, it is naturally of considerable interest, both to the producer and to the consumer, to determine the nature of the factors that determine quality and the conditions that favour its development.

The scientific study of the subject of quality was not taken up seriously until recent years. This was largely due to (*a*) want of adequate technique to measure the various subtle characters that make up quality, and (*b*) considerable amount of individual variations in regard to requirements of qualities such as taste and flavour. Progress in this line has, in consequence, been comparatively slow. Some useful results have, nevertheless, been obtained and the object of the present article is to make a brief survey of the more important findings and to indicate some of the more promising lines of future research.

Before taking up a discussion of the subject it may be useful to cite a few instances of quality in agricultural as well as horticultural crops. In the case of wheat, the milling quality is greatly valued. Recent enquiries (Bailey[1]) have shown that this is traceable not only to the variety of the grain but also to the nature of the soil on which the crop is grown and the manurial treatment which it receives. Thus, wheat grown on a heavy soil is generally 'stronger' than that raised on a light one. Likewise wheat grown in dry regions is 'stronger' than wheat grown in wet ones. High nitrogen content of the soil or application of nitrogenous fertilisers leads to increase in the nitrogen content of the grain and improved milling quality (Lawes and Gilbert,[2] Bailey, *loc. cit.*). Almost the reverse of the above is observed in the case of malting barley. Heavy soils may give good yields and even enrich the grain with nitrogen, but only the light soils yield grain of the desired quality—rich in carbohydrates but poor in regard to proteins. Application of nitrogenous fertilisers in more than moderate doses leads to diminution in quality (though the yield may increase) and consequent fall in prices.

In the case of tubers like potato and mangold-wurzel, heavy manuring leads to greatly enhanced yields but the quality of the produce suffers considerably. The tubers contain large amounts of water and partially assimilated salts, and, in consequence, possess (*a*) poorer keeping quality and (*b*) lower feeding value than those raised on similar, but unmanured or moderately manured areas.

Fruit crops generally do well on light soils, but the resulting quality is not so good as that obtained from heavy ones. Thus, a comparison of apples of the same variety grown on adjoining clay and light soil show that the fruits from the former are smaller and more green, but possess a greater proportion of sugar, acid and aroma than those from the latter. It is also the general experience of fruit growers that manures which act slowly but steadily (like farmyard manure) yield fruits of better taste and flavour than those receiving concentrated fertilisers which act rapidly.

It is a matter of common experience that market garden crops (such as cabbage), grown on mineral fertilisers, though developing to much bigger sizes, contain very much more water and perish more readily than those raised on unmanured or moderately manured soil. It has also been recently suggested that grain and fodder crops treated with organic manures are richer in regard to

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[1] Bailey, C. H., *The Chemistry of Wheat Flour*, The Chem. Catalog. Co., Inc., 1925.

[2] Lawes, J. B. and Gilbert, J. H., *J. C. S.*, 1884, **45**, 305.

vitamins and other growth-promoting factors than those receiving mineral fertilisers (Anon[3], McCarrison,[4, 5] Kottmeier,[6] Viswa Nath and Suryanarayana,[7] Breazale,[8] Krüger,[9, 10] Hunt,[11] Rowlands and Wilkinson,[12] Sirachenko[13] and Viswa Nath[14]).

The factors that contribute towards quality in beverages such as coffee, tea, cocoa, beer and wine, as also spirituous liquors such as brandy and whisky, have been the subjects of a number of researches in recent years. As the result of these enquiries, it is now recognised that, in addition to varietal differences, a number of external factors such as, altitude, soil conditions, manuring, period of rainfall, composition of the water used for brewing, the composition of the container—all contribute towards the collective impression of quality which is evaluated by the specialist taster. It is true that tasters are not infallible but it has, nevertheless, to be admitted that, in most cases, their judgment is not only reproducible by independent opinion but is also supported by popular favour.

Taste is made up of a number of components among which salinity, sweetness, sourness or pungency as the case may be, are no doubt the most dominant. There are also other subtle features to which the specialised human tongue is sensitive but which cannot be easily evaluated in terms of known chemical constituents. It is true that among the non-specialists, especially those indulging in excesses of certain kinds of foods, narcotics or beverages, tastes do not always agree and may even be quite opposed to one another. Thus it is known that one addicted to strong drinks, especially of the cheaper type, cannot make out the subtle distinctions in taste and flavour between the different brands of whisky or brandy; still less can he evaluate the lighter beverages which require an even more sensitive palate. On the other hand, the opinion of connoisseurs has invariably supported the evaluation of specialist tasters whose verdict determines, to a large extent, the prevailing market prices. It is necessary, therefore, that the producer should not only have further knowledge of the nature of the factors contributing to taste but also of the external conditions which determine them. By adequately controlling the latter, the taste of the produce can be improved with increased monetary returns to the producer.

Flavour is very much more difficult to define. It is generally associated with taste. The main constituents of flavour are often of the nature of volatile substances, but they do not contribute the entire effect. It is within the scope of the organic chemist, however, to identify the nature of the subtle constituents producing the desired effect, and, if necessary, even supply them in suitable proportions to substances lacking in them. It is also known that edaphic and other factors similar to those affecting taste also influence flavour, though to a different degree. It should be possible to define, more carefully, the nature of the relation between these factors, and even alter them, so as to obtain the desired flavour, which is often so highly prized.

In recent years, much valuable information relating to the quality of malting barley and its bearing on the brewing industry has been obtained. Thanks to the efforts of the Research Fund Committee of the Institute of Brewing, considerable progress has been made in devising and perfecting laboratory technique, and there is every prospect of it soon being possible to replace experimental maltings by rapid laboratory analyses.[15] The importance of the nitrogen content of the cereals in the brewing industry has been recognised more or less clearly ever since scientific methods were first applied (Munro and Beaven,[16] Beaven[17]). It is known that the nitrogen compounds act as dilutents of the carbohydrates of the grain and hence reduce the available extract; they also serve as essential aliments for the micro-organisms concerned and govern, to some extent, the enzymic activity; further, high nitrogen in

[3] Anon., *Science*, 1921, **54**, 469.

[4] McCarrison, R., *Brit. Med. Jour.*, 1924, **1**, 567.

[5] McCarrison, R., *Ind. Jour. Med. Res.*, 1926, **14**, 351.

[6] Kottmeier, *Kuhn. Archiv. Berlin*, 1927, **15**, 25.

[7] Viswa Nath, B. and Suryanarayana, M., *Mem. Dept. Agric. India, Chem. Ser.*, 1927, **9**, 85.

[8] Breazale, *Univ. of Arizona, Tech. Bull.* No. 16, 1927.

[9] Krüger, E., *Landw. Jahrb.*, 1927, **66**, 781.

[10] Krüger, E., *Bied. Zentr.*, 1928, **57**, 156; cited from *Chemistry and Industry*, 1928, **47**, 583.

[11] Hunt, G. H., *Ohio Agric. Expt. Stat.*, 45th Annual Report, 1928.

[12] Rowlands, M. J. and Wilkinson, B., *Biochem. Jour.*, 1930, **24**, 199.

[13] Sirachenko, I. A., cited from *Chem. Abstr.*, 1931, **25**, 3116.

[14] Viswa Nath, B., *Ind. Jour. Agric. Sci.*, 1931, **1**, 495.

[15] Rothamsted Conferences VII. Malting Barley. Ernst Benn Ltd. (1928).

[16] Munro, J. M. H. and Beaven, E. S., *J. Roy. Agric. Soc.*, 1897, **58**, 65; 1900, **61**, 185.

[17] Beaven, E. S., *J. Inst. Brewing*, 1902, **8**, 542.

barley leads to malting loss by both increased respiration and rootlet growth and also to difficulty in modification. Quality in beer depends on several factors like flavour, colour and aroma and is in the main determined by conditions of malting, hopping and fermentation. The majority of recent investigators agree that head retention, palatefulness and both colloidal and biological stability are largely dependent on nitrogenous substances derived from the original protein constituents of the barley. The maltster prefers low nitrogen barleys because they modify more readily and have a lower "malting loss", whilst the brewer knows that they give higher extracts, and, he believes, bright and relatively stable beers. The effect of these preferences has been shown by the high valuations generally placed on low-nitrogen barleys in the market. On the other hand, it has been suggested that such barley may be deficient in enzymic activity, yeast feeding material and those nitrogenous substances which are mainly responsible for palate fulness and head retention (Cluss[18], Stadler[19]). Bishop's work[20] would suggest, however, that, within one variety, the total quantity of nitrogen in barley and its quality may not be so unrelated as has been supposed by some. It is already possible to connect, quantitatively, certain factors in the brewing value of barley with nitrogen content. From a statistical analysis of some of the results obtained for barleys and malts in the course of his research, Bishop[21, 22] has derived a formula which may be used to predict the yield of extract which should be obtainable from any given sample of barley, when malted under normal conditions. This formula is based on a knowledge of the nitrogen content, moisture and thousand-corn weight of the barley. Chemical analyses are thus assuming a fundamental significance and already workers (Bishop,[23] Steven,[24] Russell and Bishop, *loc. cit.*) are studying the cultural conditions on which the various factors depend.

Breadmaking is one of the most ancient of industries, but scientific control of the various processes is not yet a feature of standardised procedure. Mass production of such an article as bread, demanding close attention to temperature, fermentation conditions and time factors, as well as a recognised standard of public taste, necessitates an intimate knowledge of "what happens". At the Symposium on Bread and Milk held in 1933 under the auspices of the Food Group of the Society of Chemical Industry, there were presented a number of communications (Jørgensen,[25] Brabender,[26] Eyre,[27] Jago[28] and Kent-Jones[29]) which related to the control of wheat so as to produce the best flour and of flour so as to produce the best bread and the forecasting of the value of flour in practice by laboratory tests. It is of course realised that wheats grown in different parts of the world yield flours of very different baking qualities. The development of elastic properties and of distensibility in dough during leavening are the most important quality factors of flour. Bakers naturally prefer what is popularly designated "strong" flour. This strength is rather difficult to define, but it may be stated that it is a condition which facilitates the making of bold, upstanding loaves of good texture. The demand for strong wheat cannot always be easily met. Fortunately, it was found that flour improved in strength and baking quality if it was stored for some time. Later on, it was found that minute quantities of certain chemicals (such as one part of persulphate in 15,000 to 20,000 of flour) produced effects as good as, if not better than, those given by long storage. The most widely used "improvers" at present are ammonium persulphate, potassium bromate or mixtures of chlorine and nitrogen trichloride. It is generally believed, however, that such treatments destroy flavour and that the craze for increased yield per acre has resulted in wheats of poor flavour.

The Food Group Symposium (*loc. cit.*) was also productive of valuable contributions (Kay,[30] Wilson,[31] Drummond[32] and Minett and Pullinger[33]) surveying the improvements

[18] Cluss, A., *J. Inst. Brew.*, 1929, **35**, 426.
[19] Stadler, H., *Woch. Brau.* 1929, **46**, 479.
[20] Bishop, L. R., *J. Inst. Brew.*, 1928, **34**, 101; 1929, **35**, 16.
[21] Bishop, L. R., *J. Inst. Brew.*, 1930, **36**, 421.
[22] Russell, E. J., and Bishop, L. R., *ibid.*, 1933, **39**, 287.
[23] Bishop L. R., *J. Inst. Brew.*, 1930, **36**, 353.
[24] Steven, A., *Zeit. Pflanz. Düng.*, 1930, **9B**, 35.
[25] Jørgensen, H., *J. S. C. I.*, 1933, **52**, 382T.
[26] Brabender, C. W., *ibid.*, 1933, **52**, 375T.
[27] Eyre, J. V., *ibid.*, p. 406T.
[28] Jago, W., *ibid.*, p. 412T.
[29] Kent-Jones, D. W., *ibid.*, p. 409T.
[30] Kay, H. D., *J. S. C. I.*, 1933, **52**, 363T.
[31] Wilson, G. S., *ibid.*, p. 403T.
[32] Drummond, J. C., *ibid.*, p. 401T.
[33] Minett, F. C. and Pullinger, E. J., *ibid.*, p. 379T.

which have been made in milk supply of recent years, and pointing out how very desirable it is that quality of milk should be raised, even at the expense of quantity, by systematic breeding. The development of "off" flavours and other defects in butter has long exercised the minds, not only of the traders, but also of scientific workers. In this connection, the effect of wrapping materials, alleged to be the cause of taints and of the development of tallowy flavour, as also the nature of the factors causing auto-oxidation of the fats, are being investigated (Davies[34]).

The cooking qualities of different specimens of *dhal* (red gram or pigeon pea, *Cajanus indicus*) vary considerably, some requiring long continued boiling to reach the desired stage, whilst others cook quickly and the object of the purchaser is naturally to acquire the latter type. Apart from the cooking qualities, it is generally found that the quality of the water used for boiling has a considerable effect upon the rate of cooking. Indeed, as has been shown by Viswa Nath *et al.*,[35] the rate of cooking depends upon two factors, namely, the amount and the kind of dissolved substances present. With neutral salts, the effect is a general retardation, whereas in the case of alkaline salts, the rate of cooking is accelerated; in either case, the effect increases with the salt concentration.

"Bloom" in meat is described as the "freshly killed appearance of the meat" and its preservation is a matter of considerable interest to the producer. The problem of ascertaining how far the conditions of freezing, storage and transport of mutton can be modified so as to improve its "bloom" and general quality has merited close co-operative investigation.[36] Loss of bloom can be closely connected with loss of water by evaporation or by sweating. To diminish loss by evaporation, it is recommended that the carcasses should be enclosed as quickly as possible in bags impermeable to water vapour.

Toughness in meat is another serious problem which has not yet been satisfactorily solved. It is known that, in many cases, prolonged exposure to atmospheric conditions helps to soften the meat and to render it fit for cooking. There are others however which continue indefinitely to be tough and thus prove to be a source of considerable annoyance to the consumers. This defect can be largely overcome by treatment with small quantities of digestive ferments such as papain. Further work is needed however to standardise the conditions in such a manner that every housewife can easily adopt it.

Growers of fruits and vegetables have been confronted with the problem of maintaining a high quality in their produce, of preventing their turning brown or developing unpleasant odour on storage and of reducing their susceptibility to fungal invasion and decay. The National Institute of Agricultural Botany at Cambridge has been doing useful work in estimating the quality of already established varieties of potatoes. The main requirements of the potatoes are that the flesh shall be white, that a minimum amount of discolouration shall be produced when they are boiled or steamed and then reheated. A floury texture is demanded by a vast majority of consumers. It is also important that the potato should have shallow eyes so that it can be peeled easily and without waste. It must also survive storage for long periods and stand transport without damage. When chipped, the outer surface should be crisp and of a rich golden brown colour, while, internally, there should be a layer soft in consistency. In addition, it is generally considered an important point that as little fat as possible should be absorbed in the process of frying. As a result of a large number of trials with tubers cooked under standard conditions, the Institute has been able to show that there is exceedingly little variation in the results of tests carried out at different times; that the same variety grown in different localities shows greater divergences in quality than different varieties raised in the same place; that colour after cooking and, to some extent, consistency of flesh are influenced by soil rather than by season and other factors (Parker[37]). Standard laboratory tests to measure the presence of certain qualities in the potato have also been devised. Thus, Tinkler[38] has recently published a method for determining, chemically, the susceptibility of potatoes to blackening

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34 Davies, W. L., *J. S. C. I.*, 1934, **53**, 117T, 148T.

35 Viswa Nath, B., Lakshmana Row, T., and Ayyangar, P. A. R., *Memoirs Dept. of Agric. India*, 1916, **4**, 149.

36 *Food Investigation, Special Report*, No. 41, H.M.S.O., 1931.

37 Parker, W. H., *J. S. C. I.*, 1932, **51**, 94T.

38 Tinkler, C. K., *Biochem. J.*, 1931, **25**, 3, 773.

on cooking, while Peacock and Brunstetter[39] have devised a chemical method of determining their suitability for chipping.

Rice is the staple food of hundreds of millions in India and in the East in general. Indeed, among the foods of men, it holds the foremost place, the estimated normal yield being 440 billion pounds of rough rice against 276 billion pounds of the second crop, wheat. More than 35 per cent. of the total cultivated area of India is under rice. There are several thousands of varieties recorded. In addition to this, a large number of new varieties are being added every year as a result of hybridisation between existing varieties.

The ultimate purpose of improvement in rice culture is to obtain grain with good hereditary qualities. Some varieties recommend themselves by high yield, others by good milling properties, keeping quality, fine taste, pleasing appearance, fitness to a variety of soil conditions, resistance to adverse weather conditions, pests and diseases, ease of harvesting and in various other ways. A thorough knowledge of the variations in the different items of qualities in rice is very essential, so that, armed with this knowledge, the breeder can attempt to combine high yields with superior quality.

The yield of head rice comprising the whole kernels is an important item both for the growers and the millers. The factors which contribute to high milling quality in rice are yet ill-defined, though it has been the experience of farmers that great care is needed to stop irrigating in due time and proceed promptly with the harvest. The prominence or otherwise of ridges on the rice kernel, formed as a result of the kernel growing against its case, the hull, would also appear to determine the milling quality of the rice. The less prominent these ribs are, the more suitable the grain is for milling.

From the point of view of the market value of the grain, there is another important quality in rice which finds expression in the appearance and texture of the grain. In common rice, a large part is vitreous (corneous) composed very largely of starch, but it contains also an appreciable amount of albuminoid substance. The more completely vitreous, the harder as a rule is the kernel, and the better the quality as this is usually judged. A part of the endosperm—a very small part in the best commercial rices—is white, opaque and chalky in texture. This part of the endosperm is relatively weak in albuminoids. The corneous rices include the best commercial varieties; they keep and stand shipment better than the usually softer, opaque rices. What is called glutinous rice has uniformly chalky and not very hard kernels. In glutinous rice, the endosperm contains considerable percentage of soluble starch and dextrin besides some maltose. Such rice is sometimes called dextrinous in distinction to starchy. It is called glutinous because it forms a sticky mass when cooked; but no substance which ought to be called gluten is responsible for this behaviour (Tanake,[40] Kikkawa[41]). Glutinous rice is hardly known in many parts of India, but it is greatly favoured in Japan and China. About 8 per cent. of the rice area of Japan is planted with such varieties and in China the estimate is as high as 20–30 per cent. They are largely used for making pastries. It would be of considerable scientific as well as practical interest to determine the nature of the relation between hard, soft and glutinous varieties of rice and to assess their relative nutritive values.

In the commoner varieties of paddy the period lapsing between the germination of the seed and the harvesting of the grain varies from about three to eight months. The ryot chooses the short period crop in anticipation of either (*a*) irrigation facilities for two or more crops in a season or (*b*) unfavourable climatic conditions which might destroy a long-standing crop. It is generally believed that short duration varieties are poorer in quality than long duration ones, because they are assumed to remove less of plant food from the soil. Thus, in South India, short duration *Kuruvai* or *Kar* varieties are not valued so much for their nutritive qualities as the long duration *Samba* varieties. Similarly in Bengal, it is held that *Aus* rice is inferior to *Aman* practically in all respects. Chemical analyses also show that *Aman* varieties are generally richer in protein, fat and potash contents than the *Aus* varieties (Basu and Sarkar[42]). If this belief were true, it would follow that although the farmer loses in total yield by

[39] Peacock, W. M., and Brunstetter, B. C., *U. S. Dept. Agric. Circ.*, 1931, 158.

[40] Tanake, Y., *J. Ind. Eng. Chem.*, 1912, **4**, 578.

[41] Kikkawa, S., *J. Coll. Agric. Tokyo*, 1912, **3**, 108-11.

[42] Basu, K. P., and Sarkar, S. N., *Ind. Jour. Med. Res.*, 1935, **22**, 745.

raising a long period crop, he gains considerably in quality. Scientific evidence to warrant the popular belief that short duration crops are deficient in nutritive constituents is still lacking.

Although in rice-growing lands, the general preference is everywhere for white rice, there are still a great number of recognised varieties of coloured rices deliberately grown, because of distinctive flavour, high yield, or the belief that they are especially nutritious. It is also stated that red rice is generally rich in iron and phosphorus. These have to be verified. The presence of red in the milled rice being itself evidence of incomplete milling, this incompleteness may explain the nutritive value of such rice.

Rice is essentially a water crop. Practically all the rice of commerce is irrigated, as is also by far the larger part of rice locally consumed by all the rice-producing countries. Irrigated rice is, in general, the more productive also. Even those varieties of rices which are cultivated dry are more productive if irrigated. McCarrison[42,43] has adduced evidence to show that the wet crop is poorer in nutritive value than the dry one. If this is found to be generally the case, it would be desirable to extend the method of dry cultivation and, if possible, improve on it so as to combine superior quality with high yield. In this connection, it may be mentioned that silicate fertilisation has been found by the authors to improve the yield of rice under dry-land conditions.

It is well known that rice prepared by husking recently harvested paddy (*a*) cooks rapidly to a shapeless paste and (*b*) causes digestive disorders on being taken. After storage for some time, however, the same rice cooks properly and is easily digested. Apart from the difficulty in husking fresh paddy without breakage, the quantity of cooked rice is very much less in the case of fresh grain than in that stored for some time. The question of storage and its effect on the nutritive value of rice requires investigation. The nature of the chemical changes taking place during storage, as also the significance of such changes in relation to the nutritive value of rice prepared out of them, would require careful scientific study. In practice, some varieties are stored for longer periods than others. Short duration crops generally require longer storage than long duration ones. A systematic study of the conditions relating to the above as also the comparative efficiencies of different methods (Srinivasan[44]) now in vogue would be of much practical interest.

In most rice-growing countries, a part of the annual output of grain—some varieties to a greater extent than others—is subjected to parboiling prior to milling. The paddy is cleaned, then soaked in water for a definite time and afterwards steamed till the outercoats just begin to burst. The conditions relating to parboiling are highly variable (Srinivasan, *loc. cit.*, p. 59), but, irrespective of this, parboiled rice is generally considered to be more nutritious than raw rice; when cooked, it keeps well for considerable lengths of time, either by itself or soaked under water. Besides, it is claimed to possess greater sustaining power than raw rice. Such rice also mills better (Ishaq[45]). Following the observations of Braddon,[46] Fletcher,[47,48] Ellis[49] and others who observed that people who eat parboiled ("cured") rice generally escape beriberi, several workers (Fraser and Stanton,[50-52] McCarrison and Norris[53]) have investigated the antineuritic value of raw and parboiled rices and shown that samples of parboiled rice, even when milled, protected pigeons from polyneuritis whereas raw polished rice caused the disease. Recently, Aykroyd[54] has shown that parboiled rice contains more vitamin B_1 and has a greater phosphate content than raw rice milled to the same extent. He has made the suggestion that the better nutritive value of parboiled rice is due to diffusion of the vitamin B_1 from the outer layers into the inner endosperm during the parboiling process. McCarrison[55] has, however, shown that vitamin A which is present in raw paddy or rice

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43 McCarrison, R., *Ind. Jour. Med. Res.*, 1928, **15**, 915.

44 Srinivasan, C. R., *Rice Production and Trade in the Madras Presidency*, 1934, p. 61.

45 Ishaq, Abder Rahman, *Dept. of Agric., Bombay, Bull.*, 1920, **99**.

46 Braddon, W., *The Cause and Prevention of Beriberi*, 1907.

47 Fletcher, W., *Lancet*, 1907, **1**, 1776.

48 Fletcher, W., *J. Trop. Med. and Hyg.*, 1909, **12**, 127.

49 Ellis, W. G., *Brit. Med. Jour.*, 1909, **2**, 935.

50 Fraser, H., and Stanton, A. T., *Studies from the Inst. for Med. Res.*, 1909, No. 10; 1911, No. 12.

51 Fraser, H., and Stanton, A. T., *Phil. Jour. Sci.*, 1910, **5**, 55.

52 Fraser, H., and Stanton, A. T., *Lancet*, 1912, **2**, 1005.

53 McCarrison, R., and Norris, R. V., *Ind. Med. Res. Memoirs*, 1924, No. 2.

54 Aykroyd, W. R., *Jour. of Hygiene*, 1932, **32**, 184.

55 McCarrison, R., *Ind. Jour. Med. Res.*, 1923, **11**, 323.

is destroyed in great part during the parboiling of paddy and that pigeons fed exclusively on parboiled rice develop symptoms of ophthalmia. McCarrison and Norris (*loc. cit.*), while confirming the above observation, have further shown that the boiling and steaming of paddy (parboiling) with subsequent sun-drying reduces its nutritive value, and that it is related to loss of vitamins A and B consequent on the action of heat and oxidation. It would appear from the above that the influence of parboiling on the vitamin content of the grains has to be more thoroughly investigated and conditions determined for their maximum conservation. No scientific study on the effect of parboiling on the chemical composition and the nutritive value of rice or on the biochemical changes undergone by the grain during the process of parboiling has also been carried out. It may be mentioned that recent observations in these laboratories have shown that parboiled, milled rice is richer in nitrogen, phosphorus and minerals in general than raw rice milled to the same extent.

At one time, rice of commerce was entirely hand-pounded. The product thus obtained was always slightly coloured and was associated with a small quantity of bran. With the advent of machinery, however, human labour (with its desirable imperfections) was steadily eliminated until to-day we find that not only exported rice but also a very large part of the grain used for home consumption is entirely mill-pounded and polished. The polishing is generally carried to such an extent that the bran layer is almost entirely removed. It is now being increasingly realised, however, that polished rice is devoid of vitamin B_1 and other essential growth promoting factors which are lost with the bran. It would be desirable, therefore, to adopt some system of pre-treating rice which would reduce losses through polishing to a minimum; to combine the pleasing appearance and the keeping quality of polished rice with the superior nutritive value of unpolished rice. It has been found that parboiling under certain standard conditions achieves this end and if this is confirmed by further experiments, such a procedure would deserve to be extensively adopted. Carefully prepared parboiled rice mills better than raw rice and keeps well. On polishing, its colour improves considerably. The finished product cooks nearly as white as raw rice.

The foregoing are but a few instances to show the importance of a systematic investigation on quality in crops. Detailed study of some of the problems mentioned above would not only throw light on the nature of physiological response of plants to a variety of conditions, but also help considerably to modify our present system of agriculture so as to combine quality with quantity. Scientific study of quality in crops is yet a virgin field of research and one from which far-reaching practical results might well be forthcoming. It is pleasing to note that some of the problems referred to in the course of this review are already under investigation at some of the research stations in this country. Particular mention may be made of the researches on quality in tea and coffee at Tocklai, Devarshola, Balehonnur, Bangalore and elsewhere; studies on rice at Dacca, Bombay, Coimbatore, Bangalore and at other stations; enquiries on the nutritive value of various foodstuffs at Coonoor, Bombay, Bangalore and a few other centres. Much more yet remains to be done and it is hoped that, in the years to come, it may be possible to combine high yields with superior quality, thus providing the consumers with cheaper and, at the same time, better acceptable and more wholesome food than in the past.

Quinochromes.

THE oxidation of the non-fluorescent Vitamin B_1 by permanganate and manganese oxides at pH 6-7, is accompanied by the production of a blue fluorescent substance, which is yellow in acids. Sulphur is not split off as sulphate but the state of combination of S changes. This product shows biological activity even though it does not give the formaldehyde-azo colour reaction for Vitamin B_1, which indicates that more than one Vitamin B_1 exists. The properties of the blue substance are discussed in an important paper by Kinnersley and collaborators (*Biochemical Journal*, 1935, **29**, 2369-2384). The authors are led to the conclusion that the view that Vitamin B_1 might be thiophyramidazine (hexahydrothiolumichrome) is no longer tenable. Vitamin B_1 appears to be pyramidine thiazole. It is probable that both the biological activity and the colour reaction are connected with the $-NH_2$ group at 6, which would therefore be capable of existing in two states of oxidation $-NH_2$ and $=NH$.

Permo-Carboniferous Life Provinces, with Special Reference to India.

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AT the recent meeting in Amsterdam (Sept. 2–7, 1935) of the Sixth International Botanical Congress, the inter-relations of the Late Palæozoic floras were discussed by various geologists and palæobotanists. After Professor T. G. Halle's Presidential Address to the Palæobotanical Section, Professor A. C. Seward, F.R.S., opened the discussion with remarks on the "Nature and significance of geobotanical provinces". He dealt, *inter alia*, with the difficulties attending a decipherment of the records of the rocks, particularly those connected with the climatic implications of extinct forms of plant life. Perhaps the most striking observation in this masterly discourse, characteristic of a man of Professor Seward's authority and experience, was that today he knew less about the value of fossil plants as tests of climate than he did forty-three years ago, when he wrote his well-known Sedgwick Prize Essay for the year 1892. Among others who followed with papers on various aspects of the problem, was Professor Halle himself, who discussed the relation between the Late Palæozoic floras of Eastern and Northern Asia (pp. 227–228).[1] Professor R. Kräusel of Frankfurt a.M. spoke on the distribution of the Devonian flora. Professor W. Gothan of Berlin dealt in two papers with the inter-relations of the Permo-Carboniferous life provinces (pp. 226; 242–244). Professor W. J. Jongmans of Heerlen discussed the distribution of synchronous floras with special reference to the movement of the poles and of continental blocks (pp. 239–242). Professor A. Renier of Brussels offered remarks on stratigraphical correlations in and between the geobotanical provinces (pp. 244–245). Lastly, the present writer read a paper on the *Glossopteris* flora of India and its phytogeographical relations (pp. 245–247), of which a summary is given below.

Immediately after the Amsterdam Congress, an international gathering of about eighty geologists and palæontologists met in Heerlen (Sept. 9–12) for the Second Congress of Carboniferous Stratigraphy under the auspices of the Geologisch Bureau of the Nederlands. Here we had the advantage of the presence of the veteran geologist Dr. W. A. J. M. van Waterschoot van der Gracht, Mr. D. N. Wadia of the Indian Geological Survey and other geologists interested in tectonic problems connected with Asia. Among many interesting and important items on the programme, Professors Jongmans and Halle presented their Amsterdam papers again under these new auspices, and in this connection the writer also had the privilege of discussing that part of his paper which dealt with the relations of the Indian Gondwana flora with those of Siberia and China.

As the space allotted for the advance abstracts of the Amsterdam Congress was necessarily limited, and as the full paper will be delayed in publication, I propose to give below an extended summary in the hope that it may be of interest to readers of *Current Science.* The full paper will appear in the *Proceedings of the Indian Academy of Sciences* for 1936.

It is generally agreed that towards the end of the Palæozoic era there existed four more or less well-defined botanical provinces. In the southern hemisphere there was the Gondwana continent, with its very characteristic *Glossopteris* flora. This flora also extended into India, which now lies north of the Equator. Gondwanaland was separated by a great Mediterranean Ocean, the Tethys, from the other three provinces which had more or less distinct floras of their own. These were, *firstly*, the Arcto-Carboniferous province, inhabiting the area now occupied by parts of Europe and eastern North America; *secondly*, the province of the *Gigantopteris* flora, developed in parts of western North America and in China, but extending south into Sumatra; *thirdly*, the Angara province, stretching eastwards from near the Ural Mountains as far as the Pacific Coast, and southwards as far as the Tarbagatai Range, within a few degrees north of Kashmir. The floras of these three northern provinces have more in common with each other than any one of them has with the Gondwana flora. Their geographical relations are best understood by viewing the globe from the Arctic pole (Fig. 1).

[1] These page references are to the *Proc. 6th Internat. Bot. Congr.* (Sec. PB), Amsterdam, 1935, Vol. II.

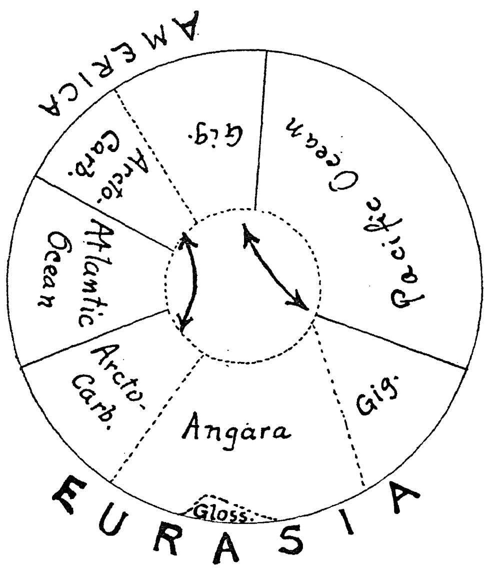

Fig. 1.

It is noteworthy that both the Arcto-Carboniferous province and the *Gigantopteris* province are cleft longitudinally into two blocks each, the blocks of each pair being separated by wide oceans, the Atlantic in the one case, the Pacific in the other. But towards the pole the two halves of each province tend to approach each other, although their actual meeting has not yet been proved. In Eurasia, the Angara flora is wedged in between the other two floras. In its affinities, so far as they are understood at present, the Angara flora is perhaps the most interesting of all, because it contains elements of all the other three floras in addition to a large proportion of genera and species peculiar to itself. The synthetic nature of the Angara flora is perhaps best understood if we look at the globe from, say, the Altai Range: Angara Land is then seen to occupy a central position, as one amongst the four life provinces. Lastly, the *Glossopteris* flora, although containing stray elements of the "northern" type, is for the most part a distinct assemblage, strongly characteristic of the southern hemisphere. This province is perhaps best seen from the southern pole, although from there India goes out of the view.

The present relative positions of these four life provinces raise palæogeographical problems which have led to much speculation. If, as seems probable, these floras were largely contemporaneous, it is difficult to imagine that two floras so distinct from each other as, for example, those of India and Sino-Sumatra should have evolved and flourished side by side, where we now find them on the map: almost cheek by jowl and crossing much the same latitudes. On the other hand, there is the equally puzzling anomaly that countries with closely related floras lie on the opposite sides of the biggest oceans of the globe: China and western North America; eastern North America and Europe; India and the southern continental blocks. But these are only a few of the problems with which the whole subject bristles. The satisfactory solution of all these problems is a thing of the distant future; but that future has been brought somewhat nearer by the recent work in Central and Eastern Asia of Swedish, American and Chinese investigators, and elsewhere by a host of workers on different aspects of the subject.

In the following necessarily condensed account, I shall first record my conclusions regarding the geological range of the Indian *Glossopteris* flora and the climatic conditions in which it was probably evolved, and then pass on to a brief discussion of its relation with the contemporary floras of Siberia and China.

THE *Glossopteris* FLORA OF INDIA AND ITS PHYTOGEOGRAPHICAL RELATIONS.

1. In India the *Glossopteris* flora probably ranged from the Upper Carboniferous to the Trias. The lower limit is indicated by the relations of the Talchir glacial beds and the earliest plant-bearing Gondwanas with marine fossiliferous horizons of determinable age, particularly in Kashmir and in the Salt Range.

Beginning in all probability as a meagre cold temperate flora in the latter part of the Talchir (Upper Carboniferous) period, it rapidly became richer as the climate became warmer (Damuda = Permian). In the Panchet stage (Lower Trias) stray elements of the then widespread *Dicroidium* (*Thinnfeldia*) flora became mingled with a still dominant *Glossopteris* flora. In the Parsora stage the *Dicroidium* element seems to have predominated over a waning *Glossopteris* flora. *Glossopteris* itself has not been recorded from Parsora itself but *Nœggerathiopsis Hislopi* and other characteristic Lower Gondwana plants co-existed with several species of *Dicroidium*, which abounded. The Parsora beds cannot possibly be of Jurassic (Upper

Gondwana) age, as C.S. Fox[2] believes: they clearly belong to the Permo-Triassic part of the Lower Gondwanas and may be even as old as the Upper Permian, as Professor Seward has suggested.[3]

2. The meagre evidence available supports the current idea that the main part of the *Glossopteris* flora was developed in a temperate climate. There is certainly no evidence that it was in any sense a glacial flora, although in sheltered spots early members of the flora may well have co-existed with the retreating ice. Nor is there any clear evidence of tropical conditions such as are believed to have existed in the Arcto-Carboniferous province.

3. The only other Carboniferous flora known in India is the geographically important Himalayan outpost of the *Rhacopteris* flora in Spiti (Thabo stage of the Po Series) which, as Gothan has suggested, is probably of Lower Carboniferous age, not Middle Carboniferous as formerly believed.

4. In several parts of Gondwana Land, particularly in South America and South Africa, species related to or identical with members of the European flora have been found associated with the indigenous southern flora. These so-called "northern" elements have generally been regarded as immigrants, but I am inclined to interpret them as remnants or descendants of the pre-existing southern flora. They occur chiefly in the earlier Gondwanas and have been compared or identified with European Upper Carboniferous or Lower Permian forms. Some of the lycopods are comparable with pre-Gondwana southern types. They may have persisted through the glacial period in regions relatively free from the rigours of the ice.[4]

5. The relations of the Indian *Glossopteris* flora with the Palæozoic flora of Angara Land are still very imperfectly known. The Angara flora, of which our modern knowledge is based chiefly upon the works of Professor Zalessky and of Miss Neuburg, contains (i) a large indigenous element, peculiar to Angara Land, (ii) a very considerable Arcto-Carboniferous element, (iii) a small but important *Gigantopteris* element, quite recently discovered, and (iv) a large number of forms more or less resembling, and a few perhaps identical with, plants characteristic of Gondwana Land. Although the Gondwana affinities may have been somewhat over-emphasised in the past, as Halle and others have suggested, there seems no doubt that the two floras were not evolved independently: some means of intermigration must have existed. Whether this was by a direct route, through Kashmir, as suggested by the writer in 1926, or by an indirect route, possibly through China, is an open question. Meanwhile, a critical comparison of typical specimens of the two floras is urgently needed; a comparison of the faunas should also be helpful. The Lower Gondwana flora of northern India, particularly that of Kashmir and the Salt Range, should be further explored; and any acquisitions of plant-fossils from the ancient coast-line of Gondwana Land, which lay along the southern margin of what is now the Himalayan chain and on the east from Assam to Burma, should be closely examined. Investigations in the intervening region between northern India and the Altai range may possibly bridge the already narrow gap between Kashmir and the southernmost Angara localities in the Tarbagatai. In that case, as tentatively suggested in 1926 (*loc. cit.*, p. 241) the Kashmir flora may be only a southern outpost of the Angara flora.

But, on the other hand, it may after all turn out that the suggested affinity of the still meagrely known Kashmir flora with that of Angara Land was only apparent, or less close than imagined. Certain geological considerations would seem, indeed, to preclude any means of terrestrial migration from Kashmir to Siberia during the late Palæozoic. D. N. Wadia's important work in N.-W. Kashmir and Hazara[5] seems to have established that the chain of the Himalayas, representing the uplifted and folded marine sediments of the Tethys, is structurally continuous round the great re-entrant angle in our northern mountain barrier. Unless further investigations reveal evidence of a break in the marine zone, either here or further to the west or east, the marine barrier between India and Siberia must have been a truly formidable one: it is now represented, as Dr. van der Gracht

[2] Fox, C. S., "The Gondwana System and related formations," *Mem. Geol. Surv. Ind.*, 1931, **58**, 189-190.

[3] Seward, A. C., "Fossil Plants from the Parsora Stage, Rewah," *Rec. Geol. Surv. Ind.*, 1932, **66**, (ii), 242.

[4] Sahni, B., "The Southern fossil floras, a study in the plant-geography of the past," *Proc. 13th Ind. Sci. Congr.*, Pres. Addr. to Geol. Sec., Bombay Meeting, Jan. **1926**, **p. 241**.

[5] Wadia, D. N., "The syntaxis of the N.-W. Himalayas", *Rec. Geol. Surv. Ind.*, 1931, **65**, (ii), 189-220.

emphasised at Heerlen, by some of the highest mountain ranges in the world, including the Himalayas and the Karakorum. In the face of these considerations, Zalessky's hypothesis of a connecting isthmus or a chain of islands across the Tethys does seem bold, but then the Gondwana resemblances of the Angara flora, which, I believe, are undeniable though they may have been exaggerated, must be explained by an indirect route, still to be discovered. This is a point on which investigations not only in China and Central Asia but also along the old Gondwana coast-line in the Nepal-Assam-Burma region may be expected to throw light.

6. Further east across the Tethys, in China, there flourished a vegetation which had much more affinity with that of the Euramerican continent, and some affinity even with that of Angara Land. With the Gondwana flora there was much less in common. But although essentially a northern flora, the *Gigantopteris* flora crossed the equator into Central Sumatra[6] where it appears to have pushed itself like a wedge into the Gondwana province. I believe that this peculiar dovetailing of the sharply contrasted northern and southern floras can only be explained on the view that originally the two provinces were far separated by the ocean (Fig. 2), but have since been brought into contact by a horizontal drift of one or (as I consider much more probable) both land areas (Fig. 3). The old Gondwana promontory of N.-E. Assam may be regarded as a pivot round which the Burmo-Chinese mass, formerly situated much further to the north, moved southwards and westwards, along the arc of a circle.

How far this suggested syntaxial bend round N.-E. Assam, compared with that which Mr. Wadia has so ably demonstrated in the N.-W. Himalayas, is supported by structural geological evidence, is for the future to show. The idea was suggested to me by purely palæobotanical considerations but, as I learned subsequently, several geologists have previously expressed the belief that the chain of the Himalayas is continued southwards round Assam into Burma and the Malayan arc of islands. The alternative view of Kingdon Ward that the Himalayas continue eastwards through China, as far as the Pacific Coast, seems quite untenable, as the region of China where his supposed eastward continuation would lie was a land area inhabited by the *Gigantopteris* flora.

It may be that the present region of Sumatra formed a *southward* promontory of the northern continent, round which the sediments of the intervening geosyncline, lying to the north of the Indo-Australian mass, became folded and bent into an angle or arc, in much the same way as round the Kashmir and Assam promontories. But the position in this region seems much more complicated, and in any case the subject is beyond our present scope. The main point one may venture to suggest is that palæobotanical explorations in the Malayan

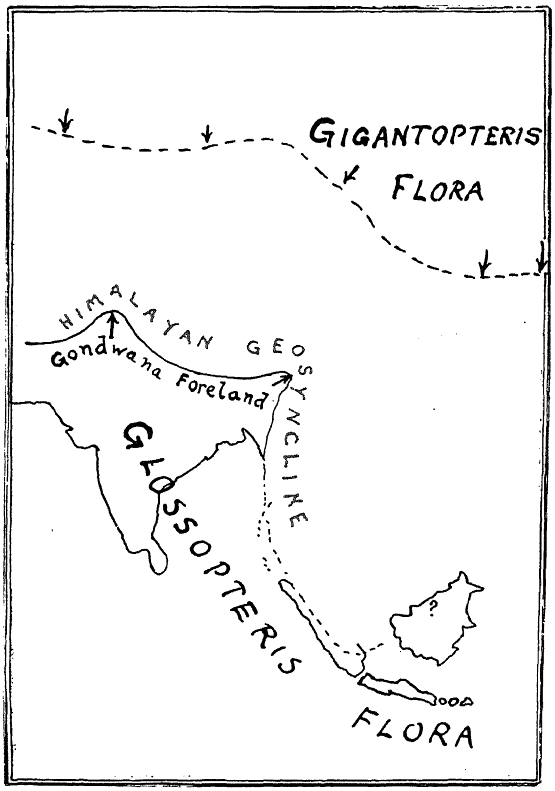

Fig. 2.

arc and further to the east should probably establish the eastward or north-eastward continuation of the tectonic boundary between Gondwana Land and the *Gigantopteris* province.

[6] Jongmans and Gothan, "Beitr. z. K. d. Flora des Obercarbons von Sumatra," *Med. Geol. Bur. Nederl. Mijngebied*, 1925, No. 2; Posthumus, O., "Palæozoic flora of Djambi," *Proc. Kon. Acad. Wet., Amsterdam*, 1927, **30**, (6); Jongmans and Gothan, (1935) "Die palæobotanische Ergebnisse d. Djambi-Expedition," *Jaarb. Mijnw. in Nederl-Ind.*, 1930, "Verhandelingen".

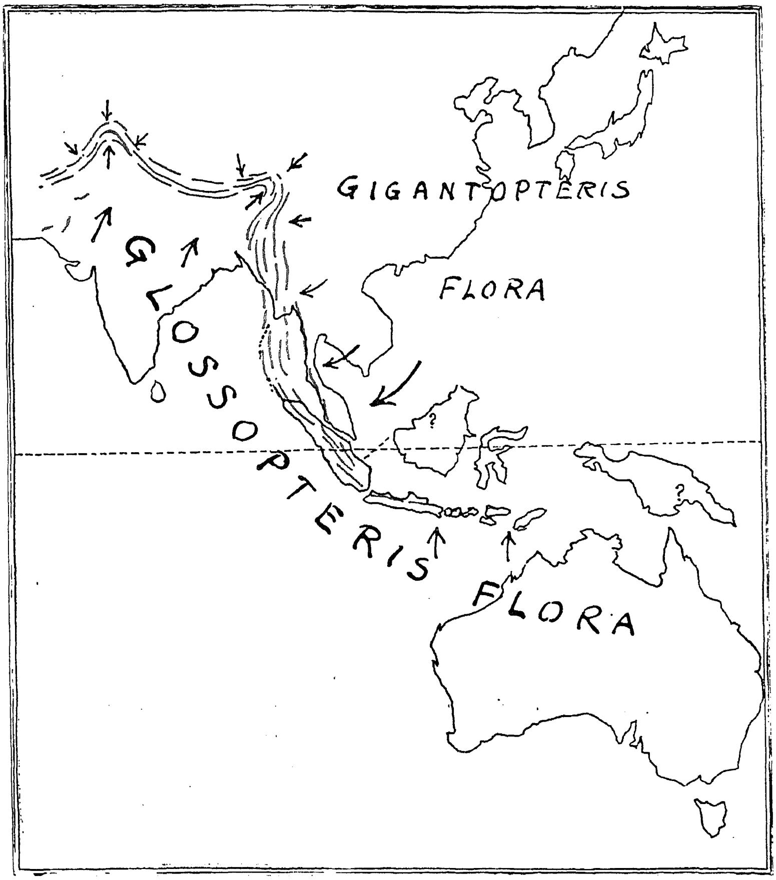

Fig. 3.

It remains to add that while the above ideas were arrived at independently I owe the original impetus for them to certain suggestive remarks made by Professor Halle, in his classical memoir on the Shansi flora,[7] where he drew attention to the close proximity of the Indian and Chinese floras and hinted that this anomalous position may have had something to do with the tectonic features of the intervening region. The above hypothesis would also explain the apparent anomaly of two climatically distinct floras lying, as they now do, athwart the same latitudes. There need not, therefore, be any serious difficulty, at least on geographical grounds, in accepting the idea that while the "Arcto-Carboniferous" flora (including its Sino-Sumatran phase) was developed in a relatively warm and humid climate, the *Glossopteris* flora was essentially a temperate flora.

In reply to an enquiry my esteemed friend Mr. Wadia also wrote to me that he thought a N.-E. tongue of the Indian horst had much to do with the acute southward bend of the Assam mountains into Burma. To him and to Dr. F. R. Cowper Reed, I am indebted for references to geological literature on this aspect, which showed that the problem has already received attention from many geologists. To mention only the most recent instance, I learned that the idea of Assam as a resistant pivot, round which the far eastern block probably drifted south-westwards into its present position, has also been recently expressed on geological grounds by M. Fromaget,[8] Director of the Geological Survey of Indo-China. Lastly, it was gratifying to find that at the Amsterdam Congress Professor Jongmans expressed ideas essentially similar to those presented in my paper, read the same day.

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[7] Halle, T. G., "Palæozoic plants from Central Shansi," *Palæontologia Sinica*, 1927, Ser. A. **2**, (i), 288-290.

[8] Fromaget, J., *Essai sur l'évolution paléogéographique de l' Indochine, etc.*, Hanoi, 1934.

With so much concurrence on the essential points, I think that we may feel satisfied about the stability of our main conclusions. About ten years ago, in an essay on a broad survey of the "Southern Fossil Floras",[9] I said that it was the scattered distribution of the previously glaciated areas of Gondwana Land that provided the main support to Wegener's hypothesis: palæobotany did not seem to me at the time to lend any clear evidence in favour of it. The Carboniferous glaciation of the southern hemisphere still appears to me to be the main pillar on which Wegener's idea rests. But I now feel that palæobotanical considerations, such as those set forth above add another, though modest, support to this remarkable theoretical edifice, at least so far as concerns the movement of continental masses through wide ranges of latitude and longitude.

[9] Sahni, B., *loc. cit.*, 1926, 233.

Antiquity of Lac and Superstitions Connected with It.

By M. Sreenivasaya.

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THE Indian Lac Industry enjoys a venerable antiquity dating as it does to the times of the Puranas. Reference to lac is made in "Mahabharata" in connection with the "*Laksha Griha*" or palace of lac, which was built to ensure and burn down the Pandavas. Kautilya mentions the product in his celebrated "Arthasastra". Coming down to very recent times Abu-l-Fazl who was in the Court of Akbar, refers to lac as being employed for varnish making.

In Ayurveda, lac is extensively employed, both for external application and internal administration. Shellac, finely powdered and mixed with honey, is given as a specific for hæmostosis. It forms one of the main ingredients of a medicated oil known as *Lakshadi Thaila* which is reputed to bring down chronic fevers, cure rheumatic pains and help the growth of fœtus during pregnancy. Decoctions of lac are administered to consumptive patients with good effect. Germicidal, febrifuge and astringent properties are attributed to lac. It is not clear to which constituent of lac the medicinal property is attributable. When decoctions are made, the body fluids of the insect which go into solution are involved but when the medicated oil is prepared, the wax and the insect fat dissolving in the oil, constitute the effective ingredients. It is not clear whether brood lac consisting of all the living insect mothers or the "*phunki*" lac containing only the dead insect bodies, is used. Local information points to the conclusion that the most effective and potent preparations are those made from brood lac which is not always available to the Ayurvedic Pundit. It is quite conceivable that the medicinal value of the wild lac is higher than that of the commercial species.

This ancient industry is naturally connected with a number of "superstitions" some of which appear to have a sound scientific foundation. Those who generally cultivate lac form a caste by themselves in Mysore, and they observe these superstitions in a most religious manner. The uncertainty which characterises lac crops is signified by the saying that "the ferry boat, lac and Tasar depend on God". These three things cannot be controlled by human beings. It is believed that all lac-bearing plants are haunted by evil spirits which are responsible for all kinds of damages and crop failures. To propitiate these evil spirits and invoke their good favour, rams, goats and chickens are offered to them in sacrifice.

The solar or the lunar eclipse, especially when it synchronises with either the swarming of larvæ or the emergence of males, is believed to be fundamentally calamitous to lac crops. On such occasions it is not unusual to find liberal animal sacrifices being offered in the field.

Host plants need a change of physiological condition before they can bear bumper crops of lac and the desired change can be brought about by repeated lac infections and successive prunings for several consecutive years. This is an observation of great value and is fully borne out in modern field practice; but an adequate scientific explanation of this observed fact cannot at present be given. The successive infections and prunings will result in altering the ratio of top to root to the optimum point.

Brood lac should not be harvested until the larvæ are seen to swarm out of their mother-cells in pretty good numbers and

settle on the tender positions of the shoot at least to the extent of about 4 inches. There is much to be said in favour of this recommendation although the latter half may have to be modified to a certain extent.

The insects resulting from prematurely cut brood lac generally lack in vigour and do not build up healthy encrustations. This is an observation with which all practical lac growers will entirely agree.

Those of the insects which swarm out in the first stage are the best since they are found to build up the thickest encrustations and maintain a vigorous state of health. Those which swarm out subsequently are weak and suffer from heavy mortality for one reason or other.

Lac does not grow at the tip of the branches.

Brood lac should be used for infecting soon after they are collected. If it be desired to keep them longer for a day or two, they should be stored up in a cool place buried under paddy husk, which prevents the profuse and rapid swarming of larvæ. This highly suggestive observation can be extended to an alteration of swarming periods within wide limits, with the ultimate idea of controlling the rate of swarming in accordance with climatic factors which may be prevalent during the period. This problem of artificially controlling the rate of larval swarming has an important practical bearing which will be referred to later.

Swarming of insects commence with the rising of the sun and cease with the setting.

Lac insects are very sensitive. On cloudy days or in chilly weather, they do not swarm out of their mother-cells. In the course of swarming, if it suddenly commences to rain, with a consequent fall in temperature, the insects are said to go back to their mother-cells, which is a fantastic idea. Under heavy showers the larvæ get washed out and have not been observed to return to their mother-cells.

Insects swarming out of the mother-cells, come down straight to the ground and then crawl up the trunk and branches and strive to find suitable places. It is believed that without first touching the ground, by way of propitiating mother earth who gave them life, the young larvæ do not commence their careers.

The man who infects lac is expected to observe certain religious rites until the "*phunki*" lac is removed from the host plants. He is prohibited from having a shave, nor can he take an oil bath. It is believed that a violation of these injunctions will lead to the branches appearing clean shaven and besmeared with oil, deprived of all encrustations which would be built up if the operator religiously observes ceremonial usages.

On the day, when "*phunki*" lac is collected from the host plant, milk is boiled underneath the host plants in a new earthenware pot. The vigour with which milk boils and foams over is taken to be an indication of the future abundance of the white filaments characteristic of healthy and bumper crops.

Hail storms and fogs do not favour the growth of lac.

If it rains in the month of January palas lac may die while April rains are fatal to kusum lac. These represent two particular rains known as salt rains which are not favourable to lac propagation.

A single cell of kusum-brood lac is equivalent to a stick of palas-brood lac.

This is supposed to give us an idea of the relative number of insects in the two different varieties of brood lac.

Lac is supposed to grow very well on the lower branches during the rainy season and on the top branches during the winter.

Most of the observations which have been detailed above, have a scientific bearing and are doubtless the result of keen observation while some of them appear to be highly fantastic.

Lt.-Col. A. D. Stewart, C.I.E., I.M.S.

It is unfortunate for India that those who serve her in an official capacity must retire at about an active middle age. New recruits are constantly joining to fill up the ranks but just as constantly do the senior and experienced ones resign when they are so capable of carrying on for many further years. In September 1935 Lt.-Col. A. D. Stewart gave up his appointment as Director of the All-India Institute of Hygiene and Public Health and Professor of Hygiene in the School of Tropical Medicine, Calcutta, in order to take up the post of Superintendent of Edinburgh Royal Infirmary.

Col. Stewart is, as we all know, a native of Scotland. He was born in 1883 and after terminating his school days in Dux he entered Edinburgh University as a Medical student in 1901. He graduated in 1906 and entered the I.M.S. in the same year. From 1907 to 1931 he was in military employment, and just before the War was Medical Officer of Health, Simla. During the Great War he saw much active service, serving in Egypt and the Suez Canal area, at Gallipoli and the landing at Cape Helles, in the Senussi expedition in Western Egypt, in Mesopotamia and as surgical specialist on the hospital ship *Vasna*, and finally as D.A.D.M.S., Bombay. He was mentioned in the final war despatch by the Government of India.

On reverting to civil employment after the War, Lt.-Col. Stewart served from 1919 as Medical Officer of Health, New Delhi,—a post which called for special qualifications as the laying-out of the Imperial Capital involved many serious problems of public health.

In 1921 he came to Bengal and served in turn as Director of the Bengal Public Health Laboratories, Director of Public Health, Bengal, and Professor of Hygiene at the Calcutta School of Tropical Medicine. In 1926–1928 he was appointed Principal of the Calcutta Medical College, and had a very strenuous time in reorganising that institution and putting it on a sound basis.

In 1929 the scheme for an All-India Institute of Hygiene and Public Health matured, and the construction of the building and its equipment were undertaken by the Rockefeller Foundation at a capital cost of Rs. 16 lakhs. Lt.-Col. Stewart was selected as Director Designate of the Institute in 1929, and in 1932 became its first Director.

Col. Stewart's knowledge of public health conditions in India and, Bengal in particular, was both wide and practical. His main experience in the field was gained as Director of the Public Health Laboratories. Consequently when the Rockefeller Foundation proposed the Institute in Calcutta, they clearly saw that Col. Stewart was the man to whom the design and the Directorship should be given. While holding this post Col. Stewart was in an ideal position for utilising his knowledge and experience. There was hardly a problem or inquiry into public health conditions of Bengal in which he was not consulted. He was Chairman of the Conference of Cholera research workers in India where his capacity for appreciating not only the main issues of field work but also the finer details of antigenic structure, were of inestimable value in guiding the diverse activities of the members as a whole. He was also a member of the Malarial Advisory Committee of the Bengal Sanitary Board where again his intimate knowledge made his opinion of great weight. One of his last meetings was on an inquiry into the Calcutta Water Supply, the administration and technical working of which he probably knew more about than any other member. In 1933 he was appointed by the Government of India—as their representative at the Office International d'Hygieno Publique at Paris where his views on such international problems as cholera were carefully listened to.

Other Activities.

His valuable work for the two medical institutions in Calcutta, however, does not complete the story of Lt.-Col. Stewart's manifold activities in Bengal. For twelve years he has been an active and zealous Fellow of the Calcutta University, and that institution owes much to him for his help and advice with regard to its public health diplomas. He has also served for many years on the State Medical Faculty of Bengal, the Bengal Council of Medical Registration, and in connexion with the inspection and regulation of medical schools and colleges throughout the Province.

He has for many years been prominent in connexion with the work of the St. John's Ambulance Brigade in Calcutta, and was for

two years Assistant Commissioner of the Calcutta District.

Members of the Staffs of the All-India Institute of Hygiene and Calcutta School of Tropical Medicine will lose, with Lt.-Col. Stewart's retirement, the services of a most loyal and devoted colleague, and a teacher of wide experience and specialised knowledge.

In addition to Lt.-Col. Stewart's own work, mention must be made of the services of Mrs. Stewart on many social and public health committees in Calcutta, and especially in connexion with the annual Calcutta Health Week.

Lt.-Col. Stewart has published many papers on public health and medical research subjects in the *Indian Medical Gazette* and the *Indian Journal of Medical Research*. He was the author of manuals on tropical hygiene and public health laboratory practice. Many of these were devoted to the question of sewage inactivation and water purification, a result of which was a valuable suggestion for the improvement and economy in the use of alum. He also published a considerable amount of extremely important work on the bacteriology of food, sewage and water while in charge of the public health laboratories. His work in Bengal during the last 15 years has contributed very materially to raising the standard of public health in the Province and towards the solution of Bengal's many and difficult problems in health welfare. He received the C.I.E. in 1934 in recognition of his valuable services to India.

Col. Stewart was a man of interests extending far beyond his work. He was keenly interested in music and while serving with a Gurkha Regiment in his early days he wrote down and collected a number of their folk melodies. He neglected no opportunities for taking up other hobbies as the above illustration shows and Geology was similarly studied not from books but from direct observation in the field. Among the numerous other activities in which he joined and encouraged was the Bratachari movement in Bengal which aims at the revival of folk music and dancing. He was widely read and never failed to be an interesting conversationalist both light and serious. During his last few years in India in spite of the many demands made on him he illustrated in no small degree the rule that the busiest man has always time to spare. No one left his room without getting his full attention, courtesy and help. He had a shrewd judgment and always grasped the main issue whether of a scientific or administrative problem. His criticism was always followed by other constructive suggestions a rare asset, which no doubt contributed largely to the continual stream of work with which he had to deal.

Both Col. and Mrs. Stewart were liked by all with whom they came in contact—no mean accomplishment—and there can be no doubt that Edinburgh has chosen wisely in recalling one of her graduates, who, we all hope, will have many more years of happiness and service in his new appointment.

H. ELLIS C. WILSON.

Craters in the Moon.

DR. F. E. WRIGHT of the Geophysical Laboratory, Carnegie Institute of Washington, recently announced before the National Academy of Sciences, his observations on the relation between the number and size of the craters on the moon. Craters with diameter of 4—8 miles are grouped in one family; those with 9—13 miles, in another and so on. The graph showing the relation between size and number is a smooth curve which is interpreted to mean that the "craters are the expression of a single mode of formation, such as volcanic, or meteoric impact or some other type". "The craters are remarkably circular in outline. The small craters have the aspect of simple depressions with walls which rise only slightly above the level of the surrounding country. They are more of the nature of pits or holes in the ground, not unlike the crater holes produced by the impact of an explosive bomb. As the size of the crater increases, the crater floor is less even and usually contains subsidiary craters and elevations."

Letters to the Editor.

CONTENTS.

The Mathematical Theory of a New Relativity.

In the September number of *Current Science*[1] some criticisms by "B. S. M." of my Theory have been published. I heartily welcome such criticisms because they give me an opportunity to elucidate the points which may not be clear. I am briefly replying to the criticisms in the various paragraphs seriatim, reserving a more detailed examination for a later occasion.

§ 1.

1. I have never claimed that my Theory deserves Harlow Shapley's characterisation of it "as one of the high lights of astronomy," and I myself was surprised at the generosity of his remarks. It is a mere presentation of a new Theory still in its infancy which, applying Newtonian principles, with necessary corrections, claims to deduce the formulæ which are the pride of Relativity. It is not for me to say anything as regards the insinuation that Shapley's reference was not based on a critical study of the article.

2. D. R. Hamilton's criticism that my of the advance of perihelion to "absurdly erroneous" results has been met by me in Chapter VI of my paper.[2]

3. "On the mathematical side not much notice has been taken."—The critic refers to the mention of my article by the Zentralblatt fur Math., and omits to refer to the *American Mathematical Monthly*.[3] He has not also referred to *Nature*.[4]

§ 2.

4. His objection to the choice of the name "A New Relativity," needs no notice. I am certainly "vehemently opposed" to the extraordinary assumptions of Einstein's Relativity, but in no way to a "principle of Relativity in any form whatsoever". I maintain that Einstein's postulates are only approximately and not exactly true.

5. I gladly welcome the admission that "Relativity is not the only example of a physical theory which appears absurd when its logical consequences are pushed to their very limit." The very fact that the Principle of Relativity (special as well as general) has been unable to make any substantial progress from any other hand except that of its creator, and even not much from him since 1916, shows that it is not the last word on the problems which it claims to solve.

6. The quotation from Jeans' *Mysterious Universe* at page 228 is not objected to, and the page of the book also was correctly given. But the critic has pounced upon a misprint and expressed his curiosity at finding this mistake in the list of references at the end. Unfortunately there were no less than 13 misprints in the first paper already pointed out in the *Errata*, and there are more misprints in the second paper other than the two mentioned by the critic, which have been corrected in the second *Errata*.

7. "There are some misstatements of fact in the author's references to Relativity the most serious of which are in connection with the observational verifications of the general theory of Relativity."—I shall deal with the subject at considerable length in Chapters X, XI and XII of my next paper, which will show that the claim of Einstein's General Relativity that it has been verified is unfounded.

8. He considers that Chazy's observational value for the advance in the longitude of perihelion of Mercury is "the best observational data".—I suppose it is a great pity that although Chazy's value was published in 1926,[5] it was overlooked by Eddington in his later works. The critic is obviously unaware of the more recent literature to be discussed in Chapter X, which will also show the great uncertainty due to certain assumptions in the calculation of the advance of the perihelion. So much so that von Gleich has actually asserted that the supposed excess of motion of the perihelion of Mercury does not exist and the Newtonian theory of gravitation needs no correction by Relativity.[6]

9. He considers that "the most satisfactory data (on the deflection of light) available at present" are those of Campbel and Trumpler.—This is relying on a rather stale literature of 1923 in ignorance of the bad exposure made by Freundlich (quoted in Chapter II, p. 25) that if necessary corrections are introduced, the three cameras of the American Expeditions of 1922 give the values 2″·20, 2″·30 and 2″·10 respectively.[7] Freundlich has discussed in detail all the previous works including those of Campbel and Trumpler and shown that the value obtained by the latter was due to an inaccuracy in balancing the observations and that their value of the deflection also is 2″·27. It will perhaps shock the critic to learn that Lanczos, a great worker on Einstein's Relativity, has also pointed out that with the necessary corrections Campbel and Trumpler's value comes to 2″·20.[8] Of the three tests, the deflection of light is the only one that is reliable, and in this Relativity has already failed.

10. (i) The later observations of St. John[9] as regards the shift of spectral lines of the Sun are supposed to be "quite satisfactory".

It will be shown in Chapter XII that the agreements are found only for different arbitrarily chosen levels for the centre and the edge, there being marked positive and negative residuals for higher and lower levels. The discrepancies range between $\pm$ 25 per cent. which can hardly be called "quite satisfactory". The discrepancy at the edge is conveniently explained by some unknown "edge effect". The discrepancy is greater when the average of $M\Sigma\left(\frac{a d\lambda}{\lambda}\right)$ is taken, which alone is the correct method. It is well known to every worker on solar physics that wave-lengths on the Sun may differ from those measured on territorial sources on account of a large number of causes.

11. As to the companion of Sirius the assumption of the "quite satisfactory" result is based on Adam's observation.[10] But Vyssotshiy[11] has shown that the density of the companion of Sirius is much less than what has been assumed so far and therefore the radius much larger. If Einstein's value is correct, then so is mine!

The following are stated to be "misstatements of a minor nature":—

12. (1) "Relativistic invariance holds in vacuum only".—Schwarschild's particular solution is of $G_{\mu\nu} = 0$. As to this Eddington says, "This is the state of the world in an empty region—not containing matter, light or electromagnetic fields, but in the neighbourhood of these forms of energy."[12]

13. "Einstein arbitrarily assumes $C + v = c$ and $c - v = c$."—In relativity the velocity of light is absolute and relative to every frame of reference is the same. Even if two systems S and S′ be moving with relative velocity v, "the resultant velocity relative to S′ is c, the velocity relative to S is also c, whatever the direction".[13]

14. "Milne's theory ignores gravitation and evades collisions."—Compare "The new theory shows that the expansion is in reality a natural phenomenon taking place in the absence of gravitation and proceeding in

spite of it" (p. 2) and "consider a swarm of particles moving in straight lines, each with a uniform velocity without *collisions or other interactions* possessing an entirely arbitrary velocity-distribution" (pp. 6–7).[14]

15. "In Relativity time is wholly imaginary and space illusory."—The unit of time is really $\sqrt{-1}$, and space has four dimensions. What more imaginary and illusive character is wanted than the confusion of space and time?

16. (1) The mathematical part of the work is "quite elementary and does not go beyond the solution of an ordinary differential equation of the second order".—No reference to any book or paper is supplied where even an approximate solution of my equation (5·9) was given before, much less the exact solution. The so-called elementary solution is by successive approximations covering two pages and a half.

17. "Looking from an æsthetic-mathematical point of view one searches here in vain for such concepts like (as) groups, tensors and generalised spaces characteristic of Relativity or functional equations, sets of points, and Finsler spaces relevant to Milne's new Relativity."—The author thinks that paper which does not use Tensors, Groups and other branches of higher mathematics is not a valuable paper at all. Such a suggestion will condemn workers like Maxwell, Bohr, Sommerfeld and many other illustrious investigators, both dead and living. In fact the claim of the New Relativity is that its formulæ are deduced on simple dynamical principles without recourse to such methods. It is not easy to appreciate what objection there can be to its simplicity.

18. Some differential equations are considered to be "not relevant".—Apparently the critic thinks that the complete theory is contained in the five Chapters already published. More have come out since.

19. (iv) The superiority of method over those of Forsyth, Morley and Pierpoint is said to have been "achieved at the cost of a little wrong mathematics". It is conceded that the solution (9·5) is "correctly obtained" but it is asserted that the next solution has been obtained wrongly. The critic says, "It is, however, absurd to use this theorem here since it cannot apply to non-linear differential equations, and moreover is not a particular integral."—It was pointed on pages 10 and 11 that for Mercury $\frac{\mu}{h^2} = 1\cdot73+10^{-13}$ and u also is nearly the same, and that k was of the order 10^{-4}. Also θ varies from 0 to 2π. It was accordingly considered too obvious to mention that the second power of $\frac{\mu}{h^2}$ $(1-2k\theta)$ as well as the product $\frac{\mu}{h^2}(1-2k\theta)$. u were negligible. If this obvious fact were borne in mind, it will be found that the general solution given by me is perfectly valid. The correctness of the solution can be easily verified by direct substitution in the differential equation. It is some consolation that the solution in elliptic functions is not called "quite elementary". The critic has not noticed the misprint $\frac{D^4}{\mu^3}$ for $\frac{D^6}{\mu^3}$.

The following observations are regarded as contrary to scientific investigations:—

20. "Nature's limits are not fixed by our capacity to observe them."—Does Nature exist only when seen by man?

21. "Relative velocity cannot mean relative velocity as actually observed, and we cannot go by measurements only."—This is a rather bad paraphrase of my remark "if relative velocity only means relative velocity as actually observed and we go exclusively by measurements only, then the relative velocity between two bodies would depend on the particular method of measurement which is chosen". This remark was in anticipation of Chapter VII, which will throw fuller light on the point.

22. "A certain concept in Relativity is unacceptable because the concept is philosophically an impossible one."—The concept referred to is, in physical language, that there exists a mysterious cosmic force of repulsion, which not only acts at a distance, but increases in intensity as the distance between the two bodies increases.

I am not the first critic to find fault with his conception. Even Einstein has been aware of the weakness of his argument and has been trying to change the assumption. In fact in a paper published in the *Proc. Nat. Acad. of Sciences* jointly by Einstein and de Sitter, λ was taken to be zero. In Cosmos, de Sitter concluded that the theory of the expanding Universe is less definite than it used to be and that we do not even know whether the curvature is positive, zero or negative, whether the universe is finite or infinite.

23. A whole paragraph is devoted to commenting on a reference to Jordan's paper in a short note at the end. It has been repeatedly emphasised over and over again in my papers that the existence of gravitons is not necessary for the Mathematical Theory.

§ 3. GENERAL RELATIVITY.

(*a*) *Advance of Perihelion.*

24. The critic says that there is "no novelty of ideas" as they go back to the work of Laplace, whose theory produced secular perturbations or, in the alternative, a high velocity of gravitation.—Obviously the critic, who has quoted profusely from the *Encyclopædia*, is not aware that Lorentz and Eddington have shown that even on Laplace's own theory perturbations could vanish to the first order terms (see Chapter VII). It has also not been mentioned by the critic that Laplace's theory was based on the idea of pressure caused by a liquid ether owing to which the velocity of propagation was directed from the attracted body towards the attracting body, whereas in my theory, the gravitational influence is propagated equally in all directions outward from the influencing body towards the influenced body, the change of sign making all the difference.

25. It is irrelevant to refer to other theories including Anding's which assumed a new law of gravitation quite *arbitrarily*, and yet did not succeed in getting any satisfactory results. It is one thing to assume arbitrarily a new law of gravitation, and it is quite another thing to deduce a new law from a single assumption of the finiteness of the velocity of propagation. I may mention that if one were to assume a new law of gravitation, I would take it to be $-\frac{\mu}{r^2}-\frac{3\mu h^2}{D^2}\cdot\frac{1}{r^4}$ which will give all the results we want and avoid all difficulties (see Chapter VII).

26. "Remembering that Sulaiman's correction factor does not depend on r, the criticisms levelled against Gerber's theory therefore apply to Sulaiman's theory equally well."—Gerber's theory (referred to by me in Chapter I, p. 4) involved the propagation of potential with finite velocity which Seeliger, Laue and Oppenheim rejected as being impossible. Gerber had also misapplied the Lagrangian equation as pointed out by Pauli. Neither of these defects can be found in my theory. Also my factor is a function of dr/dt which is a function of r, and is therefore not derivable from Gerber's potential.

27. Following in the footsteps of D. R. Hamilton the critic has emphasised at several places that my theory would lead to unforeseen perturbations, and either Mercury would go off in three centuries or the velocity of gravitation should be thousands of times more than that of light.—My replies to Hamilton's criticisms are to be found in Chapter VI, which may be referred to. As Laplace's theory led to a retardation, he was unable to explain the perturbation. My theory leads to an acceleration of motion, which can be adequately explained by the resistance of the medium through which planets pass, as is now becoming clearer from the explanations of Zodiacal light and Gegenschein phenomena. This material difference saves my theory from foundering on the rock on which Laplace's theory did.

28. It is wholly unnecessary for me to discuss the other theories relating to the advance of Mercury's perihelion. The principal defect in Einstein's theory is the unconvincing nature of its fundamental assumption of the absoluteness of the velocity of light.

(*b*) *Gravitational Deflection of Light.*

29. "Gerber's equation does not yield the value for the deflection which is certainly true, and the same should also be true of Sulaiman's equations if properly handled."—The critic has undertaken to rehandle in two ways my equations which, as shown in Chapter VII, was obtained for heavenly bodies where v'/D is small.

30. (i) He does "the straightforward thing....to write the equations of motion *ab initio* using the relation $v = D$" and curiously gets $\frac{d^2u}{d\theta^2}+u=0$. He has apparently forgotten that, as noted on p. 8, v is the velocity along $S'P=\frac{dr}{dt}\cos\alpha-\frac{rd\theta}{dt}\sin\alpha$ and not along the tangent.

31. (ii) He has verified his result "qualitatively" by putting $v = D$ in $-\frac{\mu}{r^2}\left(1-\frac{v}{D}\right)^3$. [The critic has been freely using such expressions as "absurdly erroneous", "completely false impression", "most serious misstatement", "quite elementary", "drab", "absurd to use this", "results completely against all observed values", "arbitrary", "truly amazing".] But I would refrain from using any epithet for the

critic's mathematics according to which for a light particle no matter howsoever much inclined it may be to the radius vector the form always is $-\frac{\mu}{r^2}\left(1-\frac{c}{D}\right)^3$. This is the supposed "consonance with Gerber's equation"!

32. "When the (author) states that $r\frac{d\theta}{dt}$ can never exceed the *tangential velocity* c, he assumes unconsciously that the tangential velocity is constant, but this certainly cannot be true."—There has never been any such assumption which would be contrary to my theory. I said on page 29, "it disproves the assumption in Relativity that the velocity of light in a gravitational field remains constant". But undoubtedly the change in the velocity c is extremely small.

33. "The assumption of a constant tangential velocity is equivalent to taking the central orbit as circular, and it becomes meaningless to talk of the deflection as the angle between the asymptotes of the orbit."—With the disappearance of the constancy of the velocity, the "meaninglessness" vanishes and so does the circular orbit.

34. The "third mistake" is said to be that "by showing that the least value of the expression is....the conclusion is drawn that the deflection is exactly 4/3 times the Einstein value".—It is not clear where the word "exactly" has been got from. He has apparently misread the word "nearly". On the equation, that was the minimum value only, and the critic has himself quoted my words "at least".

35. "One would naturally inquire what would be the maximum deflection possible, but the work is silent on this point."—It is shown in Chapter VII, section 5, that on that equation the maximum deflection would be 3/2 times Einstein's value. But it will be shown in Chapter XI that in the case of light the equation is only approximately true and not exactly so, thus giving a smaller value for the deflection.

(*c*) *The Shift of Spectral Lines.*

36. "No remarks appear to be necessary in this case, for according to the author's own showing the corrections provided by the New Relativity are not appreciably large and the value of the ratio is the same as Einstein's."—Apparently the critic considers that there is no credit whatsoever in obtaining on purely Newtonian principles the same value for the spectral shift, as is obtained in Relativity with the help of extraordinary assumptions and cumbersome mathematical apparatus, and by treating an electron at the Sun as being "momentarily at rest", a self-contradictory assumption.

37. The value of the shift was the same as Einstein's for light from the centre of the disc.—In the Appendix to Chapter II it is shown that as regards the shift from the limb, there is an appreciable difference in the two values. In Chapter XII (see No. 10 above) St. John's average values will be examined.

38. "No one would seriously think of adopting it as an alternative to the General Theory of Relativity for the explanation of gravitational phenomena."—I can never expect that my theory will be accepted until more accurate future observations are forthcoming to disprove Relativity still more thoroughly.

§ 4. SPECIAL RELATIVITY.

(*a*) *Relative Velocity.*

39. (1) As the Theory is a new one, it is not at all surprising that critics should feel some difficulty in the early stages of its development. In Chapter VII it has been explained that relative velocity must vary with the method of observation. The whole object of obtaining the formula for the compounding of velocities was to show that *if a messenger's double journey method be adopted*, a formula can be obtained which as an approximation would reduce to a form similar to Einstein's. Einstein has assumed his formula to be rigorously true, from which unconvincing results follow in the extreme case. If his formula were taken to be approximately true only so long as the velocities of the bodies are small compared to that of the messenger, I would have no quarrel with it. Indeed, all the results of Relativity can be incorporated in the new Theory within the limits of such an approximation.

40. "Where u and v' are velocities relative to an observer who is at rest in his own system."—In absolute space, "rest in his own system" is not the same thing as absolute rest. *If the messenger's double journey method be employed*, the relative velocity as measured must necessarily be slightly different from Newton's relative velocity.

41. "As an example of confused thinking it is hard to find anywhere in relativistic literature a parallel to the author's derivation of the equation."—Failing to grasp the essence of the theory, the critic has become

angry and uses strong language. Of course, what is not grasped must necessarily appear to be confusing.

42. "An absolute distance between two moving points is assumed as r independent of all measurement."—For Newton's absolute space and time, such an assumption is perfectly sound. My point of view is Newtonian, and the statement is in strict logical agreement with the whole trend of such thought.

43. (1) The critic "deduces an absurd consequence" by putting $v' = D = c$.—Apparently he seriously thinks that *for a double journey method* also $v' = c$, as if a messenger travelling with velocity c can overtake another body travelling away with the same velocity, and thereafter return to his source! But if $D > v'$, then on this double journey method the value for a receding body tends towards the limit $v = c - \frac{u}{2}$ which is simple dynamics. The notion of "hybrid form" is the outcome of ignoring that the method of ascertainment is a method of *the double journey of the messenger.*

44. (ii) *Fresnel's Formula.*

The relative velocity formula *according to the double journey method* is not only a function of the difference between two absolute velocities, but also a function of the individual absolute velocities themselves. It was only as an approximation that it was applied to Fresnel's experiment. For a higher approximation the formula derived on the *messenger's double journey method* would be inappropriate for Fresnel's experiment, because there the two parts of the beam though travelling in opposite directions relative to the moving water perform *only one* and *not a double journey.*

This clears up the discrepancy. The object of the new theory is to explain phenoména by applying well-known rational principles without the postulates of Relativity. So far as Fresnel's water experiment is concerned, he had himself explained it on a simple physical principle of a change in the velocity of light.

45. The transformation formulæ on pages 247–48 have been summarily dismissed as "ridiculous analogues".—They merely indicated a different method of arriving at nearly the same formula, and have not yet been actually applied. The significance of the difference will appear from Chapter VII.

(b) *The Principle of Aberration.*

46. "It is difficult to see any justification for the reduction in the intensity of force along its apparent direction. It really makes no sense to say that when the velocity of flow is D, the effective component of force observed along the apparent direction is D cos α."—It makes no sense because the word "apparent" which did not occur in the text (p. 250) has been interpolated. The dynamics of a force moving with a finite velocity is unique, and difficulty of its conception is great. As a matter of fact, it will be seen from Chapters I and VIII that the equations have been obtained on the hypothesis that there is no change in the magnitude along the resultant; and the consideration of a change in magnitude, as pointed out in Chapter VIII, has been postponed.

47. "There is an utter confusion here between velocity and force. This confusion is also responsible for the meaningless phrase 'the velocity of light ON a body moving with volocity v''."—The critic has made a capital out of the misprint in which the word "falling" was unfortunately left out after the word "light".

48. "The claim of universality is belied by assuming that in the case of light the velocity is reduced while in other cases the intensity of force is changed (for example, H in the explanation of Bucherer's experiment)."—The effective magnitude in both of these is changed because it is only their component that is effective.

49. "There is yet another inconsistency .... The universality claimed would certainly require Newton's law of attraction to be $-\frac{\mu}{r^2} : \left(1+\frac{v^2}{D^2}\right)^{\frac{1}{2}}$ leading on to Gerber's equations, but the author uses, instead, the factor $\left(1-\frac{v}{D}\right)^3$."—A reference may again be made to the Appendix (IV, pp. 259–60) which shows how the factor is derived. A further reference to Chapter VII, section 5, is invited.

50. The critic says that "it is impossible to see how $c_1 = c \cos \alpha$ and $\tan \alpha = v/c$ can be both simultaneously true where c_1, the apparent velocity of light, has its direction perpendicular to that of v, and α is the angle of aberration".—If the critic means that $c_1 = c \cos\left(\sin^{-1}\frac{v}{c}\right)$ and $c_1 = c \cos\left(\tan^{-1}\frac{v}{c}\right)$ cannot both be simultaneously true exactly, it is of course so. When v is small, the

first approximation gives $c_1 = c\sqrt{1-\frac{v^2}{c^2}}$ which can be transformed into Minkowsky's equation, in which v cannot be greater than c.

But when v is large, $\tan\alpha = v/c$ is the more accurate formula and then the second approximation gives $c_1 = c\cos\left(\tan^{-1}\frac{v}{c}\right)$ which yields

$$c_1 = \frac{c}{\sqrt{1+\frac{v^2}{c^2}}}$$

for which v can be even greater than c, even up to ∞.

51. "It is on the basis of such 'flawless' mathematics that the possibility of velocities up to ∞ is deduced, and one might well suggest to the author the derivation of his first universal principle when one of the bodies is moving with such a velocity, for example, the velocity greater than that of the messenger employed."—Apparently the critic labours under the impression that even when the velocity of recession is greater than that of the messenger the double journey method would hold good. Comment on this is unnecessary, because there can be no double journey in such a case.

(*c*) *Michelson and Morley Experiment.*

52. "By using the author's own universal principles it can easily be shown that this explanation is untenable."—The critic says that the formula should be replaced by

$$\frac{l}{c-\frac{v}{2}} + \frac{l}{c+\frac{v}{2}} = \frac{2lc}{c^2-\frac{v^2}{4}}.$$

(1) This is an obvious misapplication of the formula obtained by *the double journey method* to two *single journeys* of light. If the times for the two journeys to and fro are to be calculated *separately*, the double journey formula cannot possibly be applicable.

(2) If a double journey formula is insisted upon then the *whole* double journey should be taken as one journey and the Corollary (IV, p. 247) which gives the ratio of the apparent and real velocities should be applied, giving instead of the apparent time $\frac{2l}{c}$ the real time $\frac{2l}{c\left(1-\frac{v^2}{c^2}\right)}$.

53. The critic says that the second universal principle has been applied wrongly and that after the direction of flow has been once shifted by an angle α and the velocity changed from c to c_1, "it is therefore wrong to again compound c_1 with v, and hence the time should be replaced by $\frac{2l}{c_1}$".—In reality there is no second compounding at all. When falling on the moving surface the light is shifted forward, and its component along AB′ which alone will reach

$$A'' = c\sqrt{1-\frac{v^2}{c^2}}$$

and the time is given by

$$c_1^2t^2 = l^2 + v^2t^2 \text{ or } 2t = \frac{2l}{\sqrt{c_1^2-v^2}}.$$

In the New Relativity the reflection of light from a moving mirror is different from that from a stationary mirror. The effective incident ray is deflected forward and the effective reflected ray deflected backward by the same angle; but the ray which reaches A″ is the component of the deflected ray along AB′.

54. According to the critic the difference in times should be $-\frac{l}{c}\cdot\frac{v^2}{2c^2}$ which he says "can certainly be measured, but is contradicted by the null result of the Michelson and Morley experiment".—It has been shown above that his deduction of this difference is wrong.

(*d*) "*Fine Structure of Spectral Lines.*"

55. There was no attempt made to give any quantitative explanation, but only an indication was given in anticipation of what was to follow. The critic has wasted unnecessary words on what he naturally regards as "really a complete mystery". It must be so, until the method is announced.

5. COSMOLOGY.

56. "The only positive result is the derivation of Hubble's famous velocity-distance law."—Apparently the validity of the derivation of the equation is not challenged.

57. "This cosmological principle can be considered as a particular form of Milne's principle of equivalent observer's."—This is perhaps some admission that the principle is sound even from the relativitist's point of view, though it is a particular case. In fact my principle of the constancy of the ratio of the acceleration to velocity is quite different from Milne's principle of "equivalent observers".

58. "It is quite redundant for the purposes of deriving Hubble's law to invoke the aid of an emission theory of matter which calls to aid supernatural agencies for the

production of gravitons by the explosion of a sub-atomic shell."—The critic has overlooked section 5 (IV, pp. 236–37) where it is pointed out that the existence of gravitons is not at all necessary for the theory; light corpuscles are in themselves quite sufficient.

59. Starting with de Sitter's observed fact that the velocity of light in free space from the front and the rear of a moving star is the same, the problem was tackled from a purely dynamical point of view as to what would be the effect on the *remaining* mass if light consisted of a swarm of particles. Applying the law of the conservation of momentum and considering as one system a large mass and two particles of light before and after the latter left the former, we get

$$mv + Mv + mv = -mc + Mv' + mc \quad \text{or}$$

$$v' = \left(1 + \frac{2m}{M}\right)v.$$

This shows that the loss of such particles, when emitted owing to internal action and reaction and moving with nearly constant velocity in free space, causes an increased velocity to the remaining mass.

The critic rejects this simple explanation presumably in favour of the Relativity hypothesis that the nebulæ, though apparently dispersed in a three-dimensional space, are situated on a three-dimensional skin of a four-dimensional continuum, repelled from each other by a cosmic force increasing with the distance, resulting in a general scattering of the universe!

60. The last objection is, to borrow the critic's own words, "truly amazing". The critic by a curious method of "a simple change or (of) origin" concludes that "dR/dt has always the same sign as R, *i.e.*, the velocity is one of recession".—This is indeed marvellous. It means that even if a nebula were really approaching our system, we can by a mere change of the origin turn its velocity into one of recession instead of approach. No words are needed to expose such an elementary error. No doubt R may have any direction with the nebula, but it is always measured along the path of the nebula. On page 235 I made it clear that "if a nebula were moving in a direction making an angle θ with the line of sight from the earth and *R measured along that direction* and r along the line of sight, etc." I should have thought that even the diagram given on that page would have left no doubt.

In the new theory the velocity is not like the speed of gravitation in Relativity where "if co-ordinates are chosen so as to satisfy a certain condition which has no very clear geometrical importance, the speed is that of light; if the co-ordinates are slightly different, the speed is altogether different from that of light. The result stands or falls by the choice of co-ordinates."[15]

In conclusion, I may add that my theory is a very humble attempt to offer a dynamical explanation of the phenomena which alone are the justification for the postulates of Relativity. As it deals with such a variety of matters, I am quite prepared to concede that, even though no real mistake has yet been pointed out, there may be some, which, if rectifiable, would be gladly corrected by me. Indeed, I am myself quite conscious that my equations also are only approximately true. The theory is still in its early stages and therefore quite capable of modification. My earnest request to mathematicians and scientists is to examine the theory with an open and unprejudiced mind, and see for themselves whether anything can be made of it. If it can succeed in offering rational explanations of the mysterious phenomena on well-understood dynamical principles, the necessity for the postulates of Relativity would cease to exist, though its magnificent mathematical structure shall ever remain for our admiration.

S. M. SULAIMAN.

October 30, 1935.

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[1] 1935, **4**, 145-151.
[2] *Proceedings of the Academy of Sciences, U.P.*, **5**, pp. 126-130. See also *Science*, Nov. 1, 1935, pp. 413–15.
[3] Feb. 1935, No. 2, 124.
[4] May 11, 1935, 797.
[5] *Comptes Rendus*, 1926, **182**, 1134.
[6] *Astronomische Nachrichen*, 1931, **241**, 105-112.
[7] *Zeitschrift fur Astrophysik*, 1931, **3**, 195.
[8] *Ergebnisse Der Exakten Naturwissenschaften*, 1931, 129.
[9] *Astrophysikal Journal*, 1928, **67**, 195.
[10] *Proc. Nat. Acad.*, 1925, **11**, 382.
[11] *Astrophysical Journal*, 1933, **78**, 1.
[12] *Space Time and Gravitation*, p. 91.
[13] Eddington, *Relativity*, p. 19.
[14] *Zeitschrift fur Astrophysik*, 1933, **6**.
[15] Eddington, *Relativity*, p. 131.

WHILE thanking you for having given me an opportunity to reply to Sir Sulaiman's

rejoinder to my critical review, I must confess that I do not feel inclined to undertake again a detailed criticism of the rejoinder. The reading of Sir Sulaiman's reply has left me absolutely unconvinced and, if anything at all, has strengthened the opinions expressed in my original review. I think that the worth of any physical theory is to be assessed not by the thoroughness or otherwise of such criticism and counter-criticism but by the positive achievements to its credit. Moreover, Sir Sulaiman has met a large part of my criticism by referring to future work to be published by him and it is perhaps better to wait for these developments, for, the present Sulaiman theory does not explain anything for which Relativity does not provide an answer. There are, however, some points in Sir Sulaiman's reply, which require a reply.

According to Sir Sulaiman, Relativity has been unable to make any substantial progress from any other hand except that of its creator, and even not much from him since 1916 and this shows that it is not the last word on the problems which it claims to solve. It may be pointed out that nobody ever claimed relativity to be the last word on the subject and physics would be dead the moment its theories became last words. It is also difficult to understand the statement that there has been no progress in Relativity since 1916. Most of the modern theoretical physics has been dominated by relativistic principles and the principle of relativistic invariance has been a guiding factor in the formulation of physical laws. The idea which led de Broglie to formulate wave mechanics must really be considered a great triumph of Relativity. The more recent formulation by Dirac of the theory of the electron is another example of an achievement in relativistic theory. The power of this method has been illustrated recently by Kramers in deriving the spin of the electron from purely classical (not quantum) arguments using relativistic invariance.

Sir Sulaiman maintains, in his reply, that the equations $c + v = c$ and $c - v = c$ correctly represent Einstein's law of addition of any velocity to the velocity of light. Now, Einstein's law of addition of velocities is given by

$$v' = \frac{v + u}{1 + \frac{vu}{c^2}}$$

and if, in this, we put $u = c$, we get $v' = c$. Surely this process is not equivalent to writing $c + v = c$.

I have been represented as thinking that a paper which does not use Tensors, Groups and other branches of higher mathematics is not a valuable paper at all. I never said so, but expressed the opinion that such fundamental notions add to the æsthetic value of a paper. Sir Sulaiman claims simplicity for his theory because he does not use such concepts, but the fact is that, in the last analysis, the solution by a series of approximations of a set of differential equations is certainly more complicated than the fundamental notions of tensors, groups, etc.

"Does Nature exist only when seen by man?" asks Sir Sulaiman. I don't know, but the "principle of observables" which has been a guiding factor in modern theoretical physics and has been so ably applied by Heisenberg would appear to suggest that an answer to this question is beyond the realm of physics.

I now come to the *crucial point* of my criticism of Sir Sulaiman's theory, *viz.*, his alternative to the special theory of relativity. In my criticism, I have shown conclusively that this theory when applied to Fresnel's water experiment gives results quite contradictory to experimental values. Sir Sulaiman evades an answer to this by the remark that in this case the double journey method is inappropriate. Again, he states that this method is not applicable to the case $v' = c$. This shows, therefore, that his formulæ are not at all general and that the general double journey method, of which he makes great use, has limitations which can always be manipulated so as to give the results of relativity. The explanation now offered by Sir Sulaiman in his reply indeed makes this part of the subject more difficult to understand than before. It does not, however, surprise him that critics should feel some difficulty in understanding his theory since it is in its early stages of development. He remarks, "of course, what is not grasped must necessarily appear to be confusing." I might as well retort by remarking that what is confusing cannot certainly be grasped!

I might stop at this stage and await the more detailed examination of my criticism which Sir Sulaiman has promised for a later occasion.

B. S. M.

A Modified Gouy's Balance for the Accurate and Quick Measurements of Diamagnetic Susceptibilities.

THE specimen tube of the Gouy's balance has been modified. The modified tube consists of two tubes of which one is sealed and contains paramagnetic substance and acts as a stopper to the other tube in which the diamagnetic substance is taken. At first the pull due to the paramagnetic substance only is noted and then the combined pull due to para- as well as diamagnetic substances together is read (care being taken that the combined pull should be of attraction). By subtracting the combined pull from that due to the paramagnetic substance only, one can easily find out the repulsion due to the diamagnetic substance.

The force acting on the cylinder along its axis is given by :

$$F_x = (x_1 m_1 - x_2 m_2) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (1)$$

where x_1 and x_2 are the mass susceptibilities of the substance and the medium and m_1 and m_2 are the masses of the specimen and the medium occupying the same volume as the specimen, respectively.

If ω_g is the pull due to the empty tube only, then

$$(\omega_g = (x_g m_g - x_a m_{ag}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (2)$$

where x_g = mass susceptibility of the glass tube.

x_a = ,, ,, ,, medium.

m_g = ,, of the glass tube.

m_a = ,, of the medium displaced by the glass tube.

If ω_p is the additional pull due to the paramagnetic substance, then :

$$(\omega_p + \omega_g) = [(x_g m_g + x_p m_p) - x_a(m_{ag} + m_{ap})] H_y \frac{\partial H_y}{\partial x} \quad .. \quad .. \quad (3)$$

where x_p = mass susceptibility of the paramagnetic substance.

m_p = mass of the paramagnetic substance.

m_{ap} = mass of the medium displaced by the paramagnetic substance.

If ω_{d1} is the pull due to the diamagnetic substance, then :

$$(\omega_g + \omega_p + \omega_{d1}) = [(x_g m_g + x_p m_p + x_{d_1} m_{d_1}) - x_a(m_{ag} + m_{ap} + m_{ad1})] H_y \frac{\partial H_y}{\partial x} \quad .. \quad (4)$$

Subtracting (3) from (4) :

$$\omega_{d_1} = (x_{d_1} m_{d_1} - x_a m_{ad_1}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (5)$$

Similarly the pull due to some other diamagnetic substance can be found out and

$$\omega_{d2} = (x_{d2} m_{d2} - x_a m_{ad2}) H_y \frac{\partial H_y}{\partial x} \quad .. \quad (6)$$

Dividing (5) by (6) :

$$\frac{\omega_{d_1}}{\omega_{d2}} = \frac{x_{d_1} m_{d_1} - x_a m_{ad_1}}{x_{d_2} m_{d_2} - x_a m_{ad_2}}$$

$$\text{or } x_{d_2} = \frac{1}{m_{d_2}} \left[(x_{d_1} m_{d_1} - x_a m_{ad_1}) \frac{\omega_{d_2}}{\omega_{d_1}} + x_a m_{ad_2} \right] \quad .. \quad (7)$$

This equation has been used for calculating the susceptibilities of the substances under investigation.

TABLE I.

Experimental Results.

Substance	$-x \times 10^{-6}$ observed	$-x \times 10^{-6}$ from other authors	
Benzene ..	0·713	0·712	Int. Crit. Tables
Bromobenzene ..	0·517	0·505	Bhatnagar
Iodobenzene ..	0·473	0·471	Int. Crit. Tables
p-Xylene ..	0·704	0·736	Bhatnagar
Nitrobenzene ..	0·498	0·499	Oxley
Anisole ..	0·668	0·672	Pascal
m-Bromotoluene.	0·528	0·546	Bhatnagar
o-Nitrotoluene ..	0·526	0·532	Int. Crit. Tables
Pyridine ..	0·620	0·623	Pascal

The results obtained appear to be quite satisfactory as they clearly correspond with the values given in the tables. The experimental error varies between 0·7—1·0 per cent. The disturbances that are produced by the air draughts can be easily avoided. As for the working of the apparatus is concerned, it is found that there is a distinct improvement over the previous methods as regards simplicity and ease of operation.

The author takes this opportunity of thanking Prof. S. S. Bhatnagar for suggesting this method.

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November 20, 1935.

Magnetic Susceptibilities of Nitric Acid Solutions.

WE have determined the magnetic susceptibilities of HNO_3 solutions for over thirteen concentrations between 4 and 65%, employing a modified form of the Quincke method with photographic recording arrangement, developed by one of us.[1] The advantage of the photographic method lies in the fact that it enables simultaneous and nearly instantaneous records to be obtained for both the standard and comparison liquids, thus eliminating errors due to non-prevalence of identical conditions.

The susceptibility-concentration curve, as shown in the figure, indicates marked departure from the linear relation. As each point on the curve represents the average of a number of readings which agree to within 0·1%, it is believed that these departures from linearity are genuine. The best line drawn through the points cuts the susceptibility axis at a point corresponding to the value of $-0 \cdot 668 \times 10^{-6}$ for water in solution, which is lower than that for water in the pure state ($-0 \cdot 72 \times 10^{-6}$). The gram-ionic

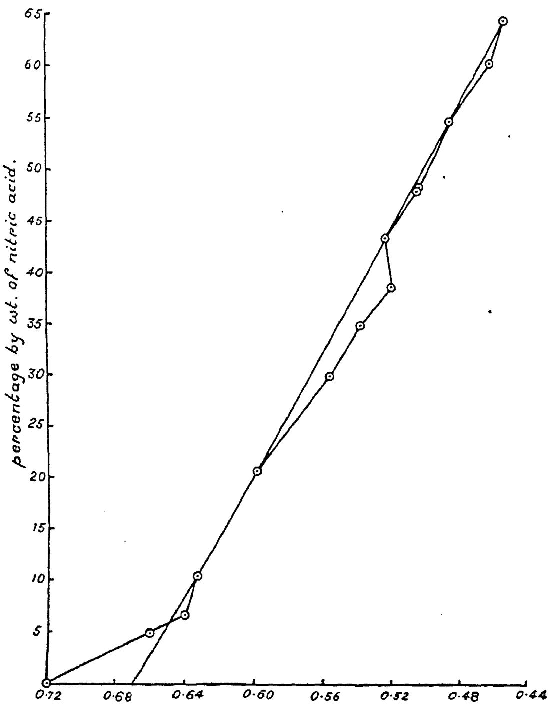

Fig. 1.

susceptibility of the NO_3 ion is found to be $-20 \cdot 83 \times 10^{-6}$ which agrees with the value of $-20 \cdot 1 \times 10^{-6}$ as given by Kido[2] but differs considerably from the value of -38×10^{-6} as calculated by Pauling.[3]

The curve shows four definite minima, corresponding to the compositions, $HNO_3 + 50\ H_2O$, $HNO_3 + 6\ H_2O$, $HNO_3 + 4\ H_2O$, and $2\ HNO_3 + 5\ H_2O$. Although the first minimum cannot be easily accounted for, the other three departures may be attributed to the formation of definite molecular complexes. The existence of such complexes or hydrates has also been indicated by other physico-chemical data, such as freezing point determinations, conductivity, etc. It may be pointed out that the deviations in the case of the last two hydrates are considerably less than those in the first two. This may be explained on the assumption that water which is known to exist in the form of associated molecules is depolymerised at higher concentrations and that the increase in susceptibility resulting from this depolymerisation partly compensates for the decrease, due to the formation of hydrates. Fuller details will be published elsewhere.

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September 16, 1935.

1 *Indian J. Phys.*, 1931, **6**, 421.
2 *Sci. Rep. Tohoku Univ.*, 1932, **21**, 149.
3 *Proc. Roy. Soc.*, 1927, **114**, 181.

The Temperature Coefficient of Susceptibility of Tetra Hydro-Naphthalene.

THE diamagnetic susceptibility of Tetra hydro-naphthalene has been studied at different temperatures, ranging from 23° C. to 25° C., using the Quincke method, with large magnetic fields. The electromagnet used was a large one of the Dubois type. In the experiments, currents used were within 7 amps. and the heating was not appreciable. Care was taken to maintain the current at a particular point. This was effected by having a travelling microscope focussed, on the pointer of an ammeter and any variation of the pointer was corrected by the adjustment of the current, by altering a resistance in parallel with the main circuit.

The tube was thoroughly cleaned first with benzene and then with sodium hydroxide, hot distilled water, and then concentrated nitric acid, and finally with hot distilled water.

The tetralene used in this investigation was kindly supplied in a pure state by Dr. M. Govinda Rau, of the Indian Institute of Science. The tube was filled with the liquid, evacuated and sealed. For observing the depression, a micro-meter eye-piece was used and the usual precautions taken.

The absolute value of susceptibility as determined from the mean of several readings is $-\cdot 688 \times 10^{-6}$. Values were taken at different field strengths and there was no variation with field strength, showing that there was no ferromagnetic impurity.

It is well known that this liquid is highly associated at ordinary temperatures and, therefore, it was thought interesting to study the effect of temperature on this compound. Nitro-benzene and other heavily associated organic liquids have been studied by Dr. Rao and Varadachari,[1] Bhatnagar[2] and Fahlenbrach[3] and the results are not concordant. Dr. Rao has found no change in the susceptibility value, while others find a decrease.

The boiling point of this liquid being 207·8° C., I studied the susceptibility of this liquid, in the range of temperature 23° C. to 70° C. At every temperature, the readings were taken several times and the mean taken as the correct value. It was found that there is no temperature effect on the susceptibility. This is in agreement with Dr. Rao's results that the break-up of association does not produce any change in the susceptibility.

In conclusion, I wish to record my grateful indebtedness to Prof. B. Venkatesachar for valuable guidance and suggestions. My thanks are due to Mr. Sibaiya for useful discussion and criticism.

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Bangalore,
December 5, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1934, **1**, 78.

[2] *Ind. J. Phys.*, 1931, **6**, 207; *Phil. Mag.*, 1930, **10**, 101; 1930, **16**, 580.

[3] *Ann. der Phys.*, 1932, **13**, 270; 1932, **14**, 521.

Ageing of Surface of Solutions.

THE effect of age of a surface on its surface tension has been investigated by several workers. They have all employed either methods involving the contact angle or those in which the surface itself would be highly disturbed (*e.g.*, drop weight method). A critical study of available methods revealed that the surface pressure technique developed by Langmuir and Adam is most suitable for studying the phenomenon. This technique has been used in the present work.

A freshly formed surface of M/500 solution of benzopurpurin is shown to exhibit a regular fall of surface tension with time.

Simultaneous with the decrease in surface tension, it has been found that a surface film is produced at the ageing surface as can be detected by pushing the barrier towards the float. If an overcrowding of the surface is effected by pushing the barrier, the surface exhibits an *increase* of surface tension with time. The force-area relations of a five-minute old surface of M/5000 solution of the dyestuff are given in Table I.

TABLE I.

Area in sq. cm.	Surface Pressure in dynes/cm.
420	0
85	1
58	2
42	4
39	6
38	10

The film appears to be more or less of the condensed type. About one-sixth of the ten-minute old surface has been found to be occupied by the dyestuff molecules. The observed rate of accumulation of the solute molecules is far less than the calculated collision frequency, the two values differing by a factor of 10^9. The adsorption appears to be of the activated type. The rate of accumulation is more than doubled for a rise of temperature by 20° The high temperature coefficient of the rate of accumulation is in accordance with the hypothesis of activation. These studies have been helpful in obtaining the potential energy curves in the neighbourhood of the interface. This technique gives a semi-quantitative method of determining the efficiency of a substance as a foam producer.

The results obtained so far have opened out some new lines of investigation. A detailed account of the work will shortly be published elsewhere.

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November 25, 1935.

Dehydrogenating Action of Sulphur Monoxide.

IN connection with the work on the mechanism of the chemical action of certain sulphur compounds, we have been studying the properties of sulphur monoxide. The oxide prepared according to the method of Schenk[1] was passed through dry liquid paraffin kept at a low temperature and found to yield hydrogen sulphide. Similar results were obtained when decalin was used for absorption. No hydrogen sulphide was obtained on absorbing the gas in tetrachlorethylene. Sulphur monoxide was found to be comparatively stable in tetrachlorethylene solutions. These solutions yielded hydrogen sulphide with liquid paraffin or decalin. Sulphur monoxide gave hydrogen sulphide readily on treatment with methyl alcohol and more slowly with ethyl alcohol. Using special micro-analytical methods we were able to show that during the production of hydrogen sulphide the methyl alcohol was converted to formaldehyde by the sulphur monoxide in terms of the following equation :

$$2\,SO + CH_3OH = H_2S + HCHO + SO_2.$$

The dehydrogenating action of sulphur monoxide can, in general, be expressed as follows :

$$RH_2 + 2\,SO = R + H_2S + SO_2.$$

The reaction can in some cases be possibly on the lines :

$$RH_2 + SO = RO + H_2S.$$

Further work is in progress.

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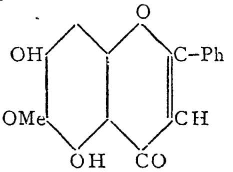
December 8, 1935.

[1] *Zeit. Anorg und. allg. Chemie*, 1934, **220**, 268.

The Constitution of Oroxylin.

"OROXYLIN" (m.p. 225°), the yellow colouring matter, isolated by Naylor and Chaplin[1] from root bark of *Oroxylum indicum* Vent. was investigated by Naylor and Dyer[2] who assigned to it the formula $C_{19}H_{14}O_6$. These authors inferred the presence of three hydroxyl groups from the preparation of an acetyl derivative, assumed to be a triacetyl derivative from the amount of oroxylin recovered from it by hydrolysis. Hydrolysis with alkali gave benzoic acid, a neutral substance, giving colour reactions of phloroglucinol, and phthalic acid. Hydrolysis with dilute alkali is stated to give benzaldehyde. Absence of a methoxyl-group was shown by a negative result for methoxy-determination by Zeisel's method.

We have investigated "Oroxylin" (m.p. 231–32°) isolated from the same source. Our carbon and hydrogen values for oroxylin agree with those of Naylor and Dyer, and we have also definitely identified benzoic acid as one of the products of hydrolysis. In other respects, however, our results differ essentially from those of these authors. We find that it contains a methoxyl group and is a dihydroxy methoxy flavone—$C_{16}H_{12}O_5$, $[C_{15}H_7O_2(OH)_2, OCH_3]$, its actual constitution being (I), *viz.*, 5 : 7 dihydroxy-6-methoxy flavone. This conclusion is confirmed by the properties of nororoxylin (the demethylation product of oroxylin), its monomethyl ether, and its dimethyl ether, all of which agree closely with those recorded for Bargellini's 5 : 6 : 7-trihydroxy flavone[3] (the baicalein[4] of Shibata, Iwata and Nakamura), 6 : 7-dimethoxy-5-hydroxy flavone,[3] and 5 : 6 : 7 trimethoxy flavone[3,5] respectively. Oroxylin is thus shown to be the 6-methyl ether of baicalein.



I

According to previous workers, oroxylin dissolves in dilute alkali with a red colour, which rapidly changes to green. We have established that this is due to an impurity associated in a small quantity with oroxylin, and oroxylin freed from this impurity, is stable to dilute alkali in which it dissolves with a permanent deep yellow colour. The colour reaction of this impurity with alkali indicates that the impurity is baicalein, which probably occurs along with oroxylin.

A detailed account of this investigation will be shortly published elsewhere.

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C. R. MEHTA.
T. S. WHEELER.
Royal Institute of Science,
and
Haffkeine Institute, Parel,
Bombay,
December 8, 1935.

[1] Naylor and Chaplin, *Year Book of Pharmacy*, **1890**.
[2] Naylor and Dyer, *J.*, 1901, 954.
[3] Bargellini, *Gazetta*, 1919, **49**, ii, 47.
[4] Shibata, Iwata and Nakamura, *Acta Phytochim*, 1923, **1**, 105.
[5] Hattori, *Acta Phytochim*, 1930, **55**, 99.

Germination of Leguminous Seeds and Urease Activity.

THE enhanced urease activity accompanying the germination of urease-containing seeds[1,2] may be due to (1) an increase in the absolute quantity of the enzyme, (2) an elaboration of activators or elimination of inhibitors and/or (3) a greater extractability of the enzyme. A series of experiments designed to test these possibilities was carried out in which the activities of the aqueous extracts of defatted powders were compared with those of the powders themselves.

0·1 g. of the powder or a quantity of the extract corresponding to 0·1 gm. of powder, was incubated for 30 minutes with 10 c.c. of a 1·0 per cent. solution of urea (in phosphate buffer of pH 6·9) at 30°·0 C. and the ammonia liberated was estimated by the aeration method. The results obtained are tabulated below.

TABLE I.

(*Urease Activity expressed in mgms. of Ammonia Nitrogen.*)

Seed Material	Extract		Powder–100 mesh	
	U.G.*	G.§	U.G.*	G.§
Dolichos biflorus, Linn.	2·4	8·7	8·5	9·0
Glycine hispida (Mœnch)	5·4	8·2	9·7	9·6
Cajanus indicus, Spreng.	5·7	8·2	8·1	8·5
Canavalia ensiformis, Dc.	19·1	27·3	26·1	28·1

*U.G. = Ungerminated.
§G. = Germinated.

The results show (1) that the activities of the germinated seed extracts are invariably greater than those of the ungerminated seed extracts, and (2) that in the case of powders, the differences between the activities of germinated and ungerminated seed materials are not marked. The activities of the powders represent the total urease content of the seed, as the enzyme is capable of acting on its substrate in the absorbed state.[3] Calculated on the basis of the activities of powders, the percentage of extractable urease is above 95 in the case of germinated seeds, and less than 70, in the case of the ungerminated seeds. Activators and paralysers, if present, will influence the activities of both extracts and powders equally.

These considerations lead to the conclusion that part of the urease exists in the seeds in an adsorbed and unextractable condition—*desmo*-urease, and that during the process of germination, it is converted into an extractable, *lyo*-form. Further work is necessary to characterise the two forms of urease.

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December 4, 1935.

[1] Yutaka Jono, *Acta. Schol. Med. Univ. Imp. Kyoto*, 1931, **13**, 211.
[2] Wei Sun Tao and Shigeru Komatsu, *Mem. College of Sciences, Kyoto Imp. Univ.*, Ser. A, **1931**, **14**, 293.
[3] Przylecki, Niedzwiedzka, and Majewski, *Biochem. J.*, 1927, **21**, 1026.

Ascorbic Acid Oxidase from Drumstick, *Moringa pterygosperma*.

IT has been shown[1] that extracts from different plants exhibit great variations in the rate of oxidation of ascorbic acid. As resistance to oxidation was usually shown by extracts which contained reducing substances other than ascorbic acid, it was inferred that such substances exerted a protective action on the acid. An example of a material in which ascorbic acid was extremely stable to oxidation and which contained a large proportion of substances titrating against iodine but not against Tillmans' reagent, was the press juice of the Indian gooseberry, *Phyllanthus emblica*. In order to examine if this juice contained protective substances, it was decided to try the effect of its addition to the press juice of drumstick, *Moringa pterygosperma*, which on account of the identity of iodine and Tillmans' titres, was known to contain ascorbic acid as the only reducing substance. The surprising result was, however, obtained that, in contradistinction to trichloroacetic acid extracts of drumstick, its *press juice* did not reduce 2 : 6-dibromophenol-indophenol : further, that the juice rapidly oxidised the reducing factor in gooseberry or in orange juice, as also solutions of ascorbic acid (B.D.H.). It was also found that if the intact drumsticks were immersed in boiling water for a short time, press juice containing the usual amount of ascorbic acid could be obtained. Thus, in drumstick juice, the presence of an enzyme system capable of

oxidising ascorbic acid and which was inactivated either by boiling, or by treatment with trichloroacetic acid, was clearly indicated. Such a system, termed "hexoxidase" was shown to be present in cabbage juice by Szent-Györgyi in 1931.[2] Recently,[3] the isolation of an ascorbic acid oxidase from *Cucurbita maxima* was reported.

A preparation of the enzyme from drumstick was obtained as follows:—The press juice was centrifuged, the supernatant liquid treated with 5 per cent. ammonium sulphate (solid) and left in the ice-chest overnight. Next morning, the heavy precipitate that had formed was filtered off and the active filtrate further treated with ammonium sulphate to 35 per cent. final concentration (about 75 per cent. saturation). The resulting fine precipitate was separated by centrifuging, dispersed in a small volume of water (about a sixth of the original volume of press juice) and filtered. Thereby a clear yellow filtrate possessing very powerful oxidising action was obtained.

The action of the enzyme was studied with ascorbic acid as substrate at the optimum pH of 5·3 (9·75 ml. primary + 0·25 ml. secondary phosphates according to Sorensen) at 37° C. The amount of ascorbic acid present at any time in the reaction mixture was determined by titrating the latter against standard solution of 2:6-dibromophenol-indophenol. In a typical experiment, 0·1 ml. of the enzyme solution, obtained as above, was found to completely oxidise 0·4 mg. of ascorbic acid to its reversible oxidation product in 3 minutes in a total volume of 5 ml. From studies so far made of the kinetics, it appears that the reaction is monomolecular and the rate of oxidation is directly proportional to the quantity of enzyme and independent of substrate concentration.

At low concentrations of cyanide and H_2S (10^{-3} M) the enzyme is greatly inhibited, which thus differs from the enzymes obtained by Szent-Györgyi (*loc. cit.*) or Tauber and co-workers (*loc. cit.*).

Guaiacum, catechol, pyrogallol and *para*-phenylenediamine were not oxidised by the enzyme preparation except in the presence of H_2O_2. This peroxidase action exhibited by the preparation is, however, totally unconnected with the oxidative mechanism which does not require H_2O_2 for its action. That the ascorbic acid oxidase acts independently of the co-existing peroxidase was also shown by the complete disappearance of peroxidase activity in presence of 10^{-4} M cyanide, when the oxidising action was still very definite. Further, alcohol and acetone were found to destroy almost completely the ascorbic acid oxidising constituent, but left the peroxidase unaffected.

These results confirm the findings of Tauber *et al.*[3] that there exists in plants, apart from the complex mechanism postulated by Szent-Györgyi (*loc. cit.*) and by Szent-Györgyi and co-worker[4], a specific enzyme capable of oxidising ascorbic acid.

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Madras,
December 4, 1935.

[1] Damodaran and Srinivasan, *Curr. Sci.*, 1935, **3**, 553; *Proc. Ind. Acad. Sci.*, 1935, **2 B**, 377.
[2] Szent-Györgyi, *J. Biol Chem.*, 1931, **90**, 385.
[3] Tauber, Kleiner and Mishkind, *J. Biol. Chem.*, 1935, **110**, 211.
[4] Szent-Györgyi and Vietorisz, *Biochem. Z.*, 1931, **233**, 236.

A New Apparatus for Carbonic Acid Estimations in Soils.

GASOMETRIC estimations of carbonic acid in soils are generally carried out with the apparatus designed by Collins. Although convenient for many purposes, Collins's Calcimeter suffers from certain inherent defects. The intervention of a rubber tubing between the reaction flask and the measuring burette may occasionally cause considerable errors. As one end of the tube adjacent to the measuring burette is open to the air, the instrument is very sensitive to atmospheric pressure fluctuations. To circumvent these difficulties, an apparatus for carbonic acid determinations has been developed in this Laboratory. This apparatus is independent of atmospheric pressure variations, and the use of a modified Thunberg[1] tube for the reaction makes it possible to mix the reactants very effectively. The apparatus can also be employed for the study of physiological functions provided the experiments are to be carried out at the room temperature.

The principle of the apparatus (Fig. 1) is the same as employed by the authors for another purpose.[2] The amount of CO_2 evolved will be proportional to the increase of pressure in the reaction bulb. If h is the increase of pressure in mm. of Brodie solution and x is the amount of CO_2 evolved in c.mm. at N.T.P. (dry), we have

$$x = h\left(\frac{V_g\frac{273}{T} + V_f a}{P_0} + A\frac{273}{T}\right),$$

where V_g = c.mm. gas in the bulb down to the "O" mark on the manometric tube,
V_f = c.mm. acid in reaction bulb,
a = Bunsen absorption coefficient of CO_2,
P_0 = pressure of one atmosphere expressed in mm. of Brodie solution,
A = area of cross-section of manometer tube in sq. mm.

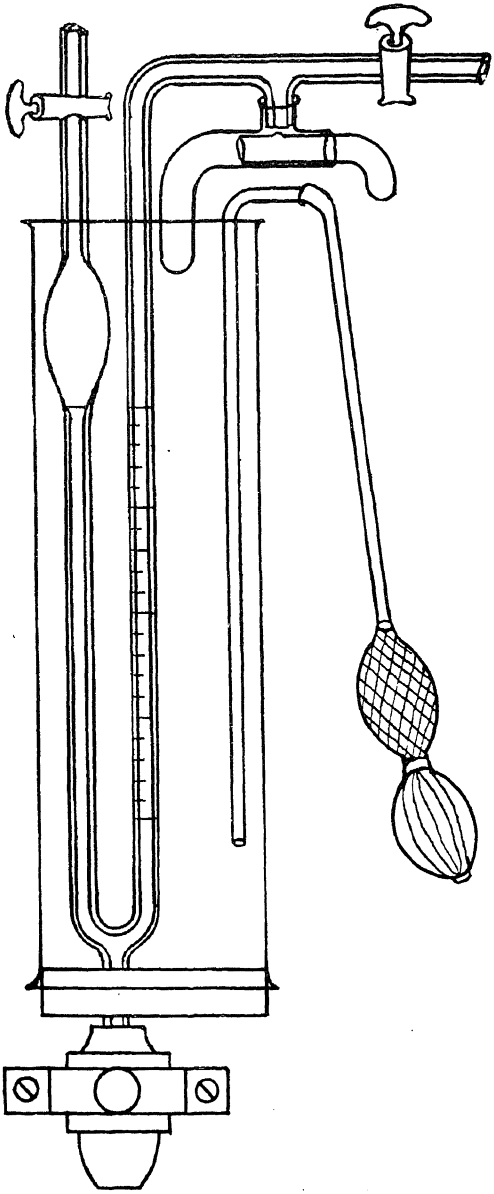

Fig. 1.

Having obtained the amount of carbon dioxide evolved in c.mm. at N.T.P. the percentage of carbon dioxide in the soil is easily computed. One c.mm. of carbon dioxide at N.T.P. weighs 0·001977 mgm., and the percentage by weight of carbon dioxide in the original sample, say x, is given by the following formula:

$$x = \frac{V \times 0 \cdot 1977}{w}$$

where V = volume of carbon dioxide in c.mm. at N.T.P.
w = weight of the sample in mgm.

The accuracy of the apparatus is ± 1·25 per cent. The various details as to construction, manipulation and computation will appear elsewhere.

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August 16, 1935.

[1] Thunberg, *Skand. Arch. Physiol.*, 1927, **35**, 163.
[2] Singh and Mathur, *Biochem. J.* (in course of publication).

Relative Wood Preservative Efficiency of the Tri- and Pentavalent Forms of Arsenic.

ALTHOUGH it has been unanimously accepted that arsenic, in all its forms, is highly toxic and is an efficient wood preservative, there has been considerable divergence of opinion on the question of the relative wood preserving efficiency of tri- and pentavalent compounds of arsenic. For example, Kunkel[1] mentions that pentavalent arsenic is less poisonous than trivalent arsenic.

The writer has had for over 42 months several test specimens of wood, of 12 species, that were treated with two different concentrations 1½ per cent. and 2½ per cent. in aqueous solution of As_2O_3 and of As_2O_5. The specimens were 24″ long, 2″ × 2″ in cross-section. They were impregnated under identical conditions of pressure (in the cold) with the above solutions. The treated pieces were allowed to air-dry, and then laid down in the antiseptic test-yard of the Forest Research Institute, Dehra Dun. The average annual rainfall in the region of the test is about 80 to 100 inches. In the case of the specimens treated with 2·5 per cent. of As_2O_3 and of As_2O_5, there is practically no difference in the present condition of the test pieces. 7 out of 12 have been destroyed in each case. One has been moderately white-ant and fungus attacked, and the rest

have been slightly fungus attacked. All the 12 untreated controls have been destroyed within 42 months.

As regards specimens treated with 1·5 per cent. of As_2O_3 and As_2O_5, the results are slightly in favour of the latter.

In view of the above, and despite the much greater tendency of As_2O_5 (as compared to As_2O_3) to leach out of wood, it would appear that the wood-preserving efficiency of As_2O_5 against termites and fungi is not inferior to that of As_2O_3.

S. KAMESAM.

Forest Research Institute,
Dehra Dun,
December 3, 1935.

[1] *Handbuch der Toxikologie*, Jena, 1901, p. 262.

Tuberculation of Water Pipes.

THE views held by different investigators with regard to the formation of tubercles in pipes are rather conflicting. Most of the earlier workers[1] consider that the tubercles are simple chemical precipitations. A few of them have also suggested that iron organisms like *Leptothrix*, *Gallionella*, *Cladothrix*, *Crenothrix*, and *Spirophyllium*, when present, play only a very subordinate or secondary rôle in the formation of these nodular excrescences. Other authors[2] have stated that tubercular incrustations are solely due to the abstraction of iron by *Gallionella*, *Leptothrix* and *Spirophyllium*. It also appears that many of the earlier workers have confused the slow appearance and steady development of the tubercles or "limpet" like structures with the sudden visitations[3] of the filamentous forms like *Crenothrix* and *Cladothrix* that occasionally occur in water reservoirs and conduit pipes. The persistence of tubercles inside the pipe, in spite of the incessant flow of water through it, has not been adequately explained.

With a view to studying the relation between the tubercle and the surrounding water in the pipe, a detailed chemical and bacteriological analysis of some of the tubercles was carried out as also a set of samples of water taken from different parts of a town supply system.

TABLE I.

Chemical Composition of Tubercles in Cast Iron Pipes.*

Constituent	Percentages on dry weight							
	Samples							
	I	II	III	IV	V	VI	VII	VIII
Iron (Ferrous as FeO)	3·7	4·6	3·1	2·1	6·7	6·4	8·2	2·4
Iron (Ferric as Fe_2O_3)	69·5	68·5	68·7	65·0	67·9	70·7	72·0	66·0
Aluminium (as Al_2O_3)	7·6	8·2	9·8	12·1	6·2	8·0	7·5	12·7
Silica	6·0	5·7	3·1	3·3	6·6	5·9	3·9	3·4
Phosphoric acid (as P_2O_5)	0·2	0·1	0·4	0·4	0·1	0·3	0·2	0·3
Manganese (as MnO_2) .. .	0·2	0·1	0·2	0·4	0·6	0·2	0·2	0·7
Calcium (as CaO)	1·3	1·4	0·8	0·7	1·8	0.9	0·6	0·7
Magnesium (as MgO)				Tra	ces			
Total nitrogen	0·05	0·05	0·14	0·20	0·09	0·11	0·08	0·15
Total carbon	1·96	1·65	3·57	5·28	1·21	1·22	1·06	2·20
Loss on ignition	8·8	8·4	12·8	11·5	9·2	8·7	9·2	11·7
Moisture content	15·57	17·44	6·83	36·79	29·48	34·87	37·56	3·93

I. Collected from dead end of the main containing filtered and chlorinated water for washing the filter units.

II. Similar to I, but collected from a different end.

III. Collected from the leading main to the General Hospital.

IV. Collected from a hatch box in the 9″ water main carrying filtered water.

V. Collected from a hatch box in the 30″ water main carrying raw river water.

VI & VII. Similar to V, but collected from different portions of the water main.

VIII. Collected from an old pipe which was cut out from the Distribution System from near the Power House. The main is 8″ in diameter.

* The samples were obtained through the courtesy of the Water Works Engineer, Trivandrum (South India) to whom the author's thanks are due.

TABLE II.

Chemical Analysis of Samples of Water from Different Parts of the System.

Sample	Parts per 100,000				
	P_H	Total Solids	Loss on Ignition	Iron	Aluminium
I	6·9	35·80	31·60	0·102	Traces
II	7·8	14·80	6·05	0·099	do.
III	7·5	11·40	7·60	0·150	do.
IV	7·5	8·50	5·12	0·165	do.

I. Raw river water, *i.e.*, the source of water supply (Trivandrum Water Supply).

II. Water of the same sort as Sample No. I, but treated with lime and allowed to settle for about 8 hrs.

III. The same water that has been filtered but not chlorinated.

IV. The same water filtered and chlorinated: representative sample of the street tap water collected from a tap about 2½ miles away from the Filter House.

From the foregoing tables, it will be observed (1) the tubercles collected from the particular system are more or less similar in their chemical composition; (2) iron in the ferric condition is the chief constituent, while, aluminium, silica, ferrous iron, calcium, magnesium, manganese, and phosphate are present in much smaller proportions: organic carbon and nitrogen are also present in small quantities; (3) the iron necessary for the formation of the tubercle comes mostly from the pipe itself, while the water passing through the pipe system supplies the other constituents. It is more than likely that a large proportion of the silica, phosphorus, manganese, and carbon is derived from the pipe, for, cast iron contains these in appreciable quantities; (4) there is a slight, but apparently progressive increase in the content of the water, as the water passes through the pipe. This would show: (*a*) iron from the pipe passes into solution in the water and (*b*) the iron of the tubercle does not therefore appear to be from the water but is mainly derived from the pipe itself; (5) the tubercles examined contain none of the better known iron bacteria,[4] but they are invariably associated with a lower form of fluorescent bacillus of the *pseudomonas* type which is derived from the water.

Direct experiments carried out with pieces of cast iron pipes, with and without a protective covering, show that tubercles appear at points bare of the coating already exposed or where as often happens the protective coating has been removed by the flow of water. A coating of tar or asphalt *does offer* some protection but that would appear to be only temporary. Even small pin points in the coating through which the iron is exposed are sufficient to start rusting which will soon be followed by tuberculation. Rusty layers do not, however, assume any definite proportions. They can be and are often partially flushed out by a vigorous stream of water. Tubercles, on the other hand, have definite conical or dome-like shapes, grow out prominently and persist even when a strong current of water is flowing through the pipes. This remarkable behaviour would appear to bear some relation to the occurrence of the *pseudomonas* which flourishes in the rusty layers and probably helps to cement them together so as to produce ultimately the characteristic tubercular structure studied by us.

The most interesting feature about this bacterium is its ability to live and grow in rust; by repeated sub-cultures in media containing pieces of metallic iron, pure strains of the organism could be easily isolated. Rusting of only a moderate nature is observed when filtered and chlorinated water is passed through the pipes. If, on the other hand, either ordinary filtered water or sterile water artificially infected with the specific organism is circulated, the rate of rusting is increased, tuberculation also sets in rapidly and in a few weeks the entire inner surface of the pipe is found dotted with incrustations.

Further work is in progress with a view to (1) identifying the associated organism and studying its physiology and the precise manner in which it contributes to the formation and persistence of tubercles, and (2) devising improved methods for providing the interior of pipes with protective coating which would resist rusting and subsequent formation of tubercles.

The author wishes to thank Prof. V. Subrahmanyan for his keen interest in the work.

S. C. PILLAI.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,

October 12, 1935.

[1] Brown, C., *Proc. of Institution of Civil Engineers*, 1903–04, Part II: Casagrandi, O., *Instituto d' igiene della R Universita di Cagliari*, 1913.

[2] Schorler, B., *Centralbl. fur Bakt.*, 1904, Abth. II.

Bd. 12; Redington, H. R., *et. al.*, *Jour. Amer. Water Works Assoc.*, 1931, **23**, 1650-93; Naumann, E. Z., *fur* Gesund-heitstech U. Stadtehyg., 1933, **25**, 34.

[3] Hirst, L. F., *Biology of Colombo Water Supply*, 1928, 209–210; Gaffey, A., *Water and Water Engineering*, 1931, **33**, 12; Brown, K. W., *Jour. Amer. Water Works Assoc.*, 1934, **26**, 1684.

[4] Ellis, D., *Iron Bacteria*, 1919, 147–154.

Chromosome Numbers in Safflower—*Carathamus tinctorius*, Linn.

GREGORY, P. J. (1935)[1] has reported from the study of the somatic mitosis the $2n$ number in Safflower as 20. The authors of the note who worked with Pusa type 24 made several counts in metaphase plates of somatic and meiotic mitoses. These revealed 24 chromosomes for $2n$ and 12 bivalents for n respectively.

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November 15, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1935, **1**, No. 11.

WITH reference to the above note regarding the chromosome numbers in Safflower (Pusa Type 24), I would like to report on the results so far derived in my present investigation of the chromosome studies of the different Pusa types of Safflower. Of these, I have so far been able to ascertain the chromosome numbers in two Pusa types (Types 1 and 27), both of which gave the $2n$ number of chromosomes as 24. So, it is fairly certain that the chromosome numbers in Pusa types of Safflower is $2n = 24$. In this connection I would like to add that the varieties I have investigated and published in my previous paper on Safflower (Gregory, P. J., 1935),[1] were distinctly the Coimbatore types and as far as the somatic counts were concerned, the $2n$ number was 20 in those cases. It may be that the variation in chromosome numbers noted above is due to a varietal difference between the Coimbatore and Pusa types of Safflower. Only further investigation, which is now proceeding, can clearly explain the exact cause of this variation.

P. J. GREGORY.

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December 9, 1935.

[1] *Proc. Ind. Acad. Sci.*, 1935, **1**, No. 11.

On Some Abnormal Flowers of *Hibiscus Rosa-sinensis*.

IN October 1933 the author collected a number of abnormal flowers from some plants in a private garden in Sagar, Mysore State. The owner of the garden had grown them from cuttings he had brought from some place on the West Coast.[1] All the flowers borne on these plants were abnormal.

Abnormality is seen in the three inner whorls, the corolla, the andrœceum and the gynœceum. The calyx is normal, with five

Fig. 1. L. S. of flower.

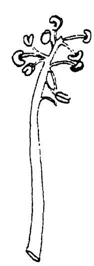

Fig. 2. A Stamen.

lobes; and the epicalyx consists of seven lobes.

The phenomenon known as *positive dédoublement*[2] is seen in the corolla, which consists of five whorls of petals, twenty-seven in all being seen in the transverse section shown in Fig. 3. The outermost whorl has the typical twisted æstivation, the second interpenetrates with the first, and the inner petals are folded in a complicated manner.

The normally monadelphous staminal tube (which is theoretically believed to be composed of five fused epipetalous members)[3] has split up into six stamens so that even here there is an increase in number. Each of these six stamens bears an indefinite number of one-celled anthers on connectives (Figs. 1 and 2). This splitting up of the staminal tube known as *Dialysis*[4] has been recorded in Hollyhock (*Althœa rosea*).

The ovary is also abnormal, the carpels having been converted into petaloid structures. This type of metamorphosis has been termed *petalody*.[5]

This combination of the three abovementioned abnormalities in *H. Rosa-sinensis* is interesting and has not been recorded before,[6] although this species has been known to show diverse kinds of abnormalities. These phenomena are generally regarded as reversionary.

H. S. RAO.

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November 23, 1935.

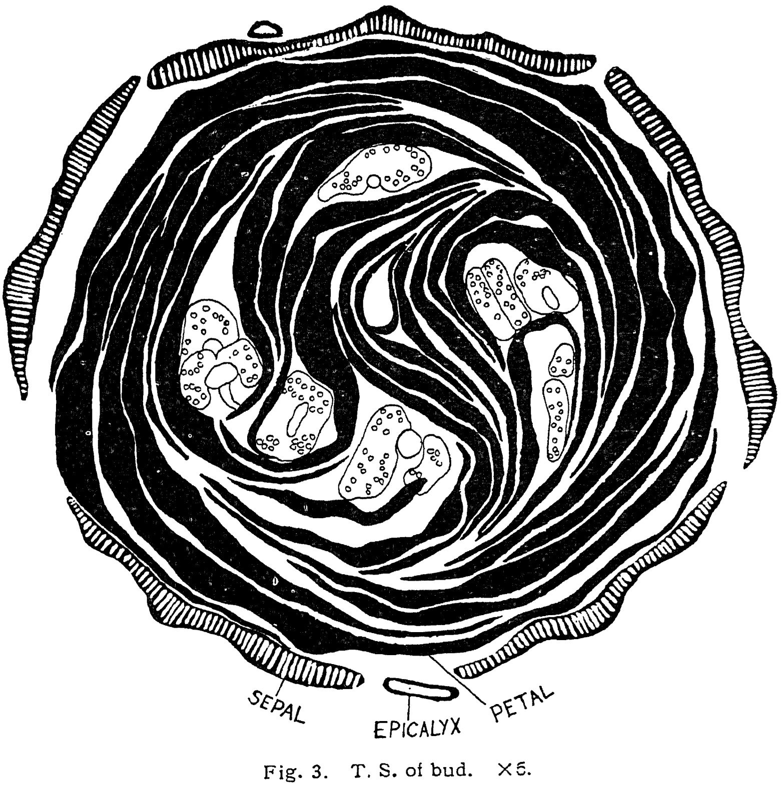

Fig. 3. T. S. of bud. ×5.

1 There is a plant showing the same type of abnormal flowers in Lalbagh, Bangalore.

2 Worsdell, W. C., *Principles of Plant Teratology*, 1916, Vol. II, 59.

3 In the normal flower of the Malvaceæ "the fertile stamens are generally very numerous and are considered to have arisen by the multiplication of five epipetalous members".—(Rendle, A. B., *The Classification of Flowering Plants*, 1925, Vol. II, 249.)

4 Worsdell, W. C., *loc. cit.*, p. 113.

5 Worsdell, W. C., *loc. cit.*, p. 204.

6 Worsdell, W. C., *loc. cit.*; Masters, T. M., *Vegetative Teratology*, 1869; Penzig, G., *Pflanzen-Teratologie*, 1921, **Band 2**; Singh, T. C. N., "Teratology of Indian Plants." *Jour. Indian Bot. Soc.*, 1935, **14**, No. 4.

A Preliminary Note on the Development of the Female Gametophyte in *Costus speciosus* L.

IN a recent article Maheshwari[1] has reviewed the work on the embryology of angiosperms that has been done in India and suggested a re-investigation of certain genera including Costus. Previous investigation on this line on *Costus speciosus* L. was carried out by Humphrey[2] who suggested a "Lilium type" of embryo-sac development.

The results of our investigation show that an archesporial cell is developed in the hypodermal layer of the nucellus, it cuts off a parietal cell and then functions as the megaspore mother-cell. The megaspore mother-cell increases in size before division. In the stages of the heterotypic prophase the nucleus, in some preparations, is observed to lie at the lower end of the protoplast (Fig. 1). The heterotypic spindle, however,

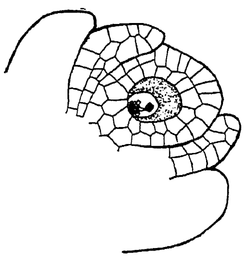

Fig. 1. × 375.

is oriented centrally and is quite sharp. A cell plate is noted on the completion of the reduction division. The homotypic spindles are arranged somewhat obliquely and as a result four obliquely-oriented tetrad of macrospores is formed (Fig. 2). The chalazal

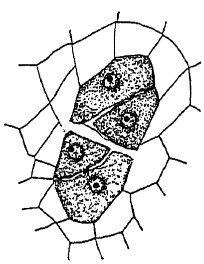

Fig. 2. × 250.

macrospore alone functions while the rest degenerate. The mature embryo-sac is eight-nucleate and is of the normal angiospermic type. The antipodals later degenerate.

The development of the embryo and the endosperm is being worked out and some interesting stages in the development of the endosperm have been obtained. A detailed account of the complete investigation will be published elsewhere in due course.

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V. VENKATESWARALU.
Botanical Laboratory,
Calcutta University,
November 28, 1935.

[1] Maheshwari, P., *Curr. Sci.*, 1935, **3**, 599-605.
[2] Humphrey, J. E., *Ann. Bot*, 1896, **32**, 1-40.

On an Abnormal Flower of *Convolvulus pluricaulis* Chois.

ONE of the flowers of *Convolvulus pluricaulis* Chois. (= *Evolvulus pilosus* Roxb.)[1] examined during a practical class showed an apparently fertile anther attached to one of the two stigmatic branches of the style (Fig. 1).

Fig. 1. × 4.

The anther is practically sessile and of the same shape and size as the other anthers of the flower. Though it had dehisced like the others, there were just two pollen grains inside and these were exactly like the normal pollen grains; the anther was obviously fertile. Serial sections of the specimen showed no suggestive differences in the internal structures of the two stigmatic branches.

Parts of the pistil being substituted by or transformed into anthers are on record and described under "Staminody of the Pistil".[2] Anthers surmounting the pistil have also been noted in a few plants.[3] Worsdell[4] records the case of an abnormal flower of *Linaria vulgaris* where, in addition to other

abnormalities, imperfect anthers were borne on the style. Baillon's[5] description of "stigmas of *Ricinus communis* as having been in one instance antheriferous" furnishes another close parallel. All the above cases are supposed to be examples of Metamorphosis. On the other hand, adhesion of carpelloid or even untransformed stamens to pistils is quite common and is described under the category of Adnation.[6]

I am inclined to consider the specimen under consideration as an example of the latter category. So far as I know this abnormality has not been recorded in the family Convolvulaceæ.

My best thanks are due to Mr. O. N. Tyagi of the First Year B.Sc. Class who drew my attention to this exceptional flower.

A. R. RAO.

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University of Lucknow,
November 23, 1935.

[1] Hooker, *Flora of British India*, 1885, Vol. iv, 218; Duthie, *Flora of the Upper Gangetic Plain*, 1911, Vol. ii, 105.

[2] Masters, *Vegetable Teratology*, 1869, 299.

[3] Masters, *loc. cit.*, 300.

[4] Worsdell, *The Principles of Plant Teratology*, 1916, Vol. ii, 206.

[5] Masters, *loc. cit.*, 300; Penzig, *Pflanzen-Teratologie*, 1922, Vol. iii, 209.

[6] Masters, *loc. cit.*, 35; Worsdell, *loc. cit.*, 236, 37.

The Kaldurga Conglomerates and the Iron Ore Series of the Bababudans, Kadur District, Mysore.*

REFERRING to the recent papers on the Bababudan rocks published by Mr. C. S. Pichamuthu,[1] I should like to offer a few remarks regarding the Kaldurga conglomerates and the Iron ore series of rocks.

The Kaldurga conglomerates were originally considered to be sediments by Bruce Foote,[2] Wetherell[3] and Smeeth,[4] but as a result of later examination Slater[5] and Smeeth[6] doubted the sedimentary origin. Subsequently, Sampat Iyengar[7] mapped the region in great detail and came to the conclusion that they were of autoclastic origin. Whether these rocks can finally be proved to be sediments or not, is difficult to say at present, but a critical examination of some of the arguments put forward by Pichamuthu shows that more than one opinion is still possible on the subject, and the evidences he has adduced are not sufficiently strong and convincing to accept a sedimentary origin for all these formations.

Many of the features such as the shape and rounding of the pebbles, sharp boundary between pebble and matrix, varied assemblage of pebbles, the difference between pebble and matrix and alternation of pebbly and non-pebbly bands, etc., are not entirely wanting in conglomerates which could be shown to be of autoclastic origin. Pichamuthu's argument[8] that the granite pebbles do not contain orthoclase or microcline (implying thereby that the intrusive Tarikere granite is not represented as pebbles in the conglomerates) appears to be based on insufficient examination. Sampat Iyengar laid much emphasis[9] on the similarity between the granite of the conglomerate and the Tarikere gneissic granite. A re-examination of the material collected by him bears out his conclusions. In the granite pebbles collected by him from the temple boulder[10] (Z_4/869, 866, etc) both orthoclase and microcline are found, though only to a limited extent. When the granite is subjected to crushing and shearing, it is only natural to expect an alteration of the felspars, the albite remaining over as the more stable under metamorphic conditions whereas orthoclase would get converted into sericite and muscovite. Sericite is no doubt found largely in the granitic pebbles and they might have been formed from the alteration of the potash felspars.

B. Rama Rao, in the course of his detailed examination of the Shimoga Belt during the last field season, has obtained many distinct evidences of ripple marks, current bedding, rain prints and other undoubted indications of sedimentation in the quartzites and some of the conglomerates of that region. It may be probable that even the Kaldurga conglomerate has had a sedimentary origin, but the evidences adduced by Pichamuthu are not strong enough to warrant such an assumption. Moreover, the evidences for shear and crushing are clearly indicated and it remains yet to be proved if this has taken place in a pure sedimentary conglomerate, or in a complex of igneous rocks, or even in a mixed series of igneous rocks and sediments. The evidences now available, however, do not justify a hasty conclusion and the inference that the Tarikere granite has played no part in the formation of the "Granite Pebbles" of the Kaldurga conglomerates is unwarranted. The question of the precise mode of origin of these rocks

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merits a considerably more detailed investigation from various aspects than what has been done at present.

The geological section[11] drawn across the Kaldurga conglomerate represents a syncline near the Kaldurga hill and an overfold near the Nandi-Hosahalli valley. The map, however, indicates only the direction of the dips in some places and their magnitude is not known. Sampat Iyengar's original map shows that the dips are not consistent over any large area, particularly in the eastern band, though the general trend in the western bands is eastwards and that of the masses to the south of Nandi is north to north-north-eastwards. In the absence of a systematic mapping of the formations into definite beds, the interpretation of the precise tectonic features becomes very difficult. While the synclinal structure yet remains somewhat doubtful, the overfold need not be assumed at all. The separation of the schists may have taken place by stoping away of a portion of the tilted general succession by the intrusive granite exposed in the Nandi-Hosahalli valley.

The problem of the ferruginous quartzites again confronts us with many difficulties and the arguments of Pichamuthu offer no conclusive proof either, of a sedimentary origin. For instance, the dominance of MgO over CaO together with that of Fe_2O_3 over FeO has been claimed to be a positive indication[12] but one may as well argue, from the same analyses, that the dominance of Na_2O over K_2O, if taken into consideration, does not support such a contention.[13] It has been assumed that the sediments were derived from spilitic rocks, but these have neither been mapped nor shown to exist in any large masses. Judging from the descriptions,[14] they are only of a local development and do not appear to be very different from the Lingadhalli and Santaveri Traps. The chemical analyses of these latter, however, do not show any large percentage of Na_2O and the assumption of a spilitic suite requires yet to be proved.

The occurrence of "interformational folding" has been claimed to be noted in the ferruginous quartzite and taken to be a very good proof of sedimentation.[15] It is doubtful if these bandings can be taken to be true bedding or deposition planes. Bandings are noted to have originated in several ways and in these rocks metamorphism has obviously played a great part in producing many structural and mineralogical changes. Pichamuthu himself notes as one of the effects of igneous intrusion[16] "the banding of the rocks have been emphasised and the iron stones in the neighbourhood recrystallised." Anyway, it is difficult to place much reliance on a few isolated structural peculiarities and accept them as definite proof of sedimentary origin.

The finding of the Fossilwood[17] in the Iron ores is very interesting, particularly in view of the fact that these rocks have formed under conditions totally different to those that gave rise to the banded ferruginous quartzites. Until more material and information are obtained, we can draw no satisfactory conclusions.

That Bababudanite is of secondary origin and not an original constituent of the amphibolites was pointed out by Jayaram[18] as far back as 1923. He then opined that the amphiboles were derived from the alteration of impure calcareous grits and tuffs. Apparently, Pichamuthu also shares with Jayaram the view regarding the secondary character of bababudanite, but the precise mode of development of this mineral yet remains a doubtful point. In an earlier communication Pichamuthu and M. R. Srinivasa Rao[19] suggested that the amphiboles have developed at the intrusive contacts of the traps with the iron ore rocks and that they had little or nothing to do with the origin of the latter. But this view has been subsequently modified. Pichamuthu[20] now regards the bababudanite-magnetite schists as due to metamorphic differentiation of sediments derived from the spilitic rocks. As already remarked, the existence of spilites has not been proved, though it appears likely we have, in this region, some keratophyres and soda felsites (Galipuje Felsite). But, the relationship of these with the banded iron ore series is not definitely known.

Regarding the age relationship between the Tarikere and the Bababudan series, Pichamuthu agreeing with the inferences of Smeeth and Sampat Iyengar states that "the Tarikere series is younger than the Bababudan series not because of its intrusive character, but considering the stratigraphic sequence".[21] But the original maps reproduced in his papers with slight modifications do not lend support to this inference. The Kaldurga conglomerate does not appear to be a basal formation and whether the Tarikere and Bababudan series are marked by any unconformity or not is unknown and much more detailed work will be necessary

before we can come to any definite conclusion on these and other controversial points.

M. B. RAMACHANDRA RAO.

Mysore Geological Department,
Bangalore,
December 6, 1935.

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[1] C. S. Pichamuthu: *Proc. Indian Acad. Sci.*, 1935, **2**, (3), 254–277; *Curr. Sci.*, 1935, **3**, 606–608. *Half-Year. Jour. Mys. Uni.*, 1935, 8, No. 1.

[2] R. B. Foote, *Mem. Mys. Geol. Dept.*, I, pp. 29-31.

[3] E. W. Wetherell, *Rec. Mys. Geol. Dept.*, IV, 92-98.

[4] W. F. Smeeth, *Rep. Chief. Ins. of Mines in Mysore*, 1901, p. 18.

[5] H. K. Slater, *Rec. Mys. Geol. Dept.*, VII, Pt. 2, p. 4.

[6] W. F. Smeeth, *Rec. Mys. Geol. Dept.*, XIV, Pt. 1, pp. 25-26.

[7] P. Sampat Iyengar, *Rec. Mys. Geol. Dept.*, XV, Pt. 2, pp. 106 116.

[8] C. S. Pichamuthu, *op. cit.*, pp. 265, 273-274.

[9] P. Sampat Iyengar, *op. cit*, pp. 107, 115.

[10] *Ibid.*, p. 111.

[11] C. S. Pichamuthu, *op. cit.*, pp. 262-63, Figs. 2 and 3.

[12] C. S. Pichamuthu, *op. cit.*, pp. 24, 37.

[13] A. Holmes, *Petrographic Methods and Calculations*, p. 437; also F. W. Clarke "Data of Geochemistry," *U.S.G.S. Bull.* 695, pp. 27-28.

[14] C. S. Pichamuthu, *op. cit.*, pp. 6, 17.

[15] *Ibid.*, p. 31.

[16] *Ibid.*, p. 9.

[17] *Ibid.*, p. 16.

[18] B. Jayaram, *Rec. Mys. Geol. Dept.*, XX, Pt. 2, p. 40.

[19] C. S. Pichamuthu and M. R. Srinivasa Rao, *Curr. Sci.*, 1933, **1**, 276-277.

[20] C. S. Pichamuthu, *op. cit.*, p. 24; also *Curr. Sci.*, 1935, **3**, 606-608.

[21] *Ibid.*, p. 11.

I HAVE read through the remarks offered by Mr. M. B. Ramachandra Rao on the results of my work on some of the rocks of the Shimoga Schist Belt, and I am afraid that many of these remarks are based on a rather superficial reading of my papers. It is after more than five years of field and laboratory investigation that I have come to the conclusion that the conglomerates, quartzites and banded ferruginous quartzites of this area are possibly sedimentary in origin, and I do not think that I can reasonably be accused of either basing my observations on "insufficient examination" or being "hasty" in my conclusions.

I am perfectly aware that "many of the features such as the shape and rounding of the pebbles, sharp boundary between pebble and matrix, varied assemblage of pebbles, the difference between pebbles and matrix, and alternation of pebbly and non-pebbly bands, etc., are not entirely wanting in conglomerates which could be shown to be of autoclastic origin." But it is the cumulative effect of all these and other characters found in one particular bed, that I consider more important. I am not as sure as Rao, however, that a varied assemblage of pebbles can be present in an autoclastic conglomerate; certainly not, at any rate, the great variety that I have noticed and described in the Kaldurga conglomerates.[1]

Further, he states "Pichamuthu's argument that the granite pebbles do not contain orthoclase or microcline.... appears to be based on insufficient examination." Rao is obviously not aware that by the courtesy of the Director of the Mysore Geological Department, I had an opportunity of examining not only the particular slides he refers to (Z_4/869, 866) but also several others, and I am sure I have found no microcline or orthoclase. There is, no doubt, a little muscovite in the granite pebbles, but not enough to suggest that all the original potash-felspars were converted into this mineral.

I am particularly pleased to read from Rao's remarks that evidences of sedimentary origin of some of the rocks of the Shimoga Schist Belt have recently been obtained by B. Rama Rao. These discoveries strengthen my contention that some of these rocks have had a sedimentary origin. I would like to point out, however, that it is not quite fair to characterise my views arrived at after a detailed study of the various aspects of these rocks as "hasty" or "unwarranted" while according to Rao, ripple marks, current bedding and even "rain prints" recorded by Rama Rao in these metamorphosed rocks are "undoubted evidences of sedimentation"!

With reference to the tectonics of the area, the V-shaped outcrops of beds surrounding Nandi village,[2] indicate a pitching fold. Rao criticises me for "assuming" an overfold here, but himself proceeds to *assume* that the structure might have been caused by the intrusion of the granite.

Regarding the banded ferruginous quartzites, the great dominance of magnesia over lime has been considered both in the Lake Superior Region[3] and in Singhbhum[4] as evidence of sedimentation and in support of my conclusions, I have only followed this line of argument and have drawn attention to the similar relationships existing in the Bababudans.

In regard to the occurrence of spilitic rocks, it will be seen from a paper of mine to be shortly published elsewhere, that there is in this area, a soda-rich series of rocks

comprising albite granites, albite syenites, keratophyres, soda felsites, oligoclase dolerites, albite basalts, albitites and albite schists, and that the distribution of these rocks is not quite so "local" as Rao seems to think. Is it far-fetched to suggest that sediments derived from such a terraine would be rich in soda?

Rao would have it that metamorphism has been the cause of banding exhibited by the ferruginous quartzites. In *support* of this he quotes me and says "Pichamuthu himself notes as one of the effects of igneous intrusion 'the banding of the rocks have been emphasised and the ironstones in the neighbourhood recrystallised'." Rao has missed the significance of the word "emphasised" used by me; it obviously implies that the bandings were there before they were metamorphosed and that they were subsequently enhanced by metamorphism.

To any one who has not read my papers, Rao's statement, "that bababudanite is of secondary origin and not an original constituent of the amphibolites was pointed out by Jayaram as far back as 1923," might convey the impression that I was not aware of this. I have referred in one of my papers[5] to Jayaram's views who considered "that the occurrence of this mineral is precisely comparable to that of tourmaline in the altered acidic rocks of the Champion gneiss series". The other officers of the Mysore Geological Department did not, however, share with Jayaram in this view. My colleague, M. R. Srinivasa Rao, and I were the first to point out that the mineral was developed as a result of thermal metamorphism.[6] I am frankly surprised at Rao suggesting that I have now changed my views regarding the origin of this mineral in the schists. I have done no such thing. That I still adhere to the view that bababudanite has always originated due to contact metamorphism, becomes clear on page 30 of my paper on "The Iron Formations and Associated Rocks of the Eastern Bababudans" where I say "they (the bababudanite-magnetite schists) are formed by the thermal metamorphism of certain of the original layers in the ironstones"; also on page 37, where I have said, "like the mineral bababudanite, these amphibole magnetite schists have also originated as the result of contact metamorphism".

With reference to the age relationship between the Tarikere and the Bababudan Series, I have nowhere suggested that the Kaldurga conglomerate is a basal formation. When I say that "The Tarikere Series is younger than the Bababudan Series, not because of its intrusive character, but considering the stratigraphical sequence," I do not imply a stratigraphic break between the two Series. All that I mean is that the rocks belonging to the so-called Tarikere Series (mainly the conglomerates) overlie those which are supposed to belong to the Bababudan Series (the iron formation, etc.).

CHARLES S. PICHAMUTHU.
Central College,
Bangalore,
December 13, 1935.

[1] C. S. Pichamuthu, *Proc. Ind. Acad. Sci.*, 1935, **2B**, 265 268.
[2] *Ibid.*, p. 262.
[3] Van Hise and Leith, *U. S. Geol. Surv. Mon.*, 1911, **52**, 506.
[4] Percival, *Trans. Min. Geol. Inst. India*, 1931, **26**, 200.
[5] C. S. Pichamuthu, *Curr. Sci.*, 1935, **3**, 608.
[6] C. S. Pichamuthu and M. R. Srinivasa Rao, *Curr. Sci.*, 1933, **1**, 276-77.

Pungency in Chillies (*Capsicum annuum*): A Mendelian Character.

IN a letter to *Current Science*[1] under the above title, K. Ramiah and M. R. Pillai state as follows:—

> "The inheritance of a large number of characters in chillies has been studied by Deshpande (1933) but we have not come across any reference to the inheritance of pungency. It has therefore been considered that information given below with regard to this character will be of interest."

The inheritance of pungency has been studied by me and the results were reported in the *Scientific Reports*, Imperial Institute of Agricultural Research, Pusa, 1930–31, p. 37 and published in the *Indian Journal of Agricultural Science*, Vol. V, No. IV, Aug. 1935, 513–16. Both the references have evidently been overlooked by the authors. Their results, however, agree with mine in so far as the F_1 and F_2 generations are concerned.

R. B. DESHPANDE.
Botanical Section,
Imperial Institute of Agricultural
Research, Pusa,
November 25, 1935.

[1] *Curr. Sci.*, 1935, **4**, 236.

Moisture Variation Indices of Soils in Relation to their other Physical Properties.*

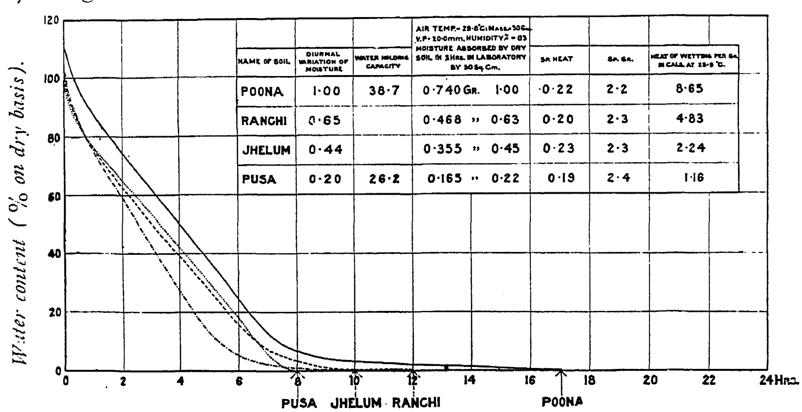
By M. S. Katti, B.Sc.
(*Research Student, Meteorological Office, Poona.*)

In two recent papers[1,2] it was shown that during the clear season when the surface soil contains only hygroscopic moisture, there is a regular diurnal exchange of moisture between the soil and the air. Later,[3] it was observed that this variation of moisture content in the soil is a definite characteristic or "index" of that soil. It is interesting to study the "moisture-variation-index" in relation to other important physical properties of the soil (see Fig.).

The sequence of the moisture variation indices of different soils as observed in the open is practically the same as that of their power to absorb water vapour when exposed under known conditions of temperature and humidity in the laboratory. The water-holding capacities of a few soils (expressed on air-dry basis) are given below :—

The values of the heat of wetting at 25·9° C. for different soils run parallel to those of moisture-variation-index, being large for the black cotton soils and small for the alluvial soils.

In determining the moisture content of a soil, the sample is usually kept in the steam oven "till the weight becomes constant". An exact study of the rate of drying in a steam oven is very instructive. The weight-time curves (see Fig.) for four typical soils starting with about 100% water (on dry basis) not only show the time for complete drying but also the rate of drying at different moisture contents. The times taken by different soils for attaining a steady minimum weight at 100° C. are in the same order as their moisture-variation-indices.



NAME OF SOIL	DIURNAL VARIATION OF MOISTURE	WATER HOLDING CAPACITY	AIR TEMP.- 29·8°C; MASS- 30 GM. V.P.- 20·0mm, HUMIDITY % - 83 MOISTURE ABSORBED BY DRY SOIL IN 3 HRS. IN LABORATORY BY 30 Sq. Cm.		SP. HEAT	SP. GR.	HEAT OF WETTING PER GM. IN CALS. AT 25·9 °C.
POONA	1·00	38·7	0·740 GR.	1·00	·0·22	2·2	8·65
RANCHI	0·65		0·468 ,,	0·63	0·20	2·3	4·83
JHELUM	0·44		0·355 ,,	0·45	0·23	2·3	2·24
PUSA	0·20	26·2	0·165 ,,	0·22	0·19	2·4	1·16

Time in hours.

Soil			Water-holding capacity
Poona	..	..	38·7 %
Sholapur	..	..	40·9 ,,
Hagari	..	..	30·9 ,,
Bangalore	..	..	24·0 ,,
Pusa	..	..	26·2 ,,
Lyallpur	..	..	22·8 ,,

The black cotton group of soils is able to retain 15% more of water than the alluvial group.

The similarity in the behaviour of a number of physical properties of different soils to their moisture-variation-indices is striking.

The above work was done under the guidance of Dr. L. A. Ramdas, Agricultural Meteorologist, Poona.

* Presented at the Colloquium, Meteorological Office, Poona, on 26-11-1935.

[1] Ramdas, L. A., and Katti, M. S., *Indian J. Agric. Sci.*, 1934, **4**, 923-37.

[2] Ramdas, L. A., and Katti, M. S., *Curr. Sci.*, 1934, **3**, 24-25.

[3] Ramdas L. A., and Katti, M. S., *Curr. Sci.*, 1935, **3**, 612-13.

Obituary.

Henry Fairfield Osborn (1857-1935).

THE sad death of Henry Fairfield Osborn, Zoologist, Palæontologist, Educationist, Author and Administrator, at the age of 78, has created a gap among the American men of Science which it would be hard to fill. President Osborn—as he was generally known in America since he became the President of the Board of Trustees of the American Museum of Natural History in 1903 after the death of President Jesup—made very valuable contributions to the sciences of Zoology, Palæontology and Biology; a great deal of his Zoological and Palæontological work was essentially biological, in that it contributed to an understanding of the nature, continuance and evolution of life. In addition, his services to the cause of Education and his work as an administrator and author, are so remarkable that any of them would have won him an outstanding place amongst the leading workers of the times. Osborn was born on the 8th of August 1857. His father, William Henry Osborn, was a Founder and for many years President of the Illinois Central Railroad, and from him apparently young Osborn inherited his great administrative talents. He was educated in the Columbia Grammar School and Lyons Collegiate Institute of the New York City, and later graduated at Princeton College where he was strongly influenced by the teachings of the well-known Geologist Professor Arnold Guyot. Taking up practical field work in the Museum of Geology and Archæology at Princeton soon after his graduation, he became the leader of the palæontological section of the University Expeditions to Colorado and Wyoming in 1877 and 1878. In 1878–79 he took courses in Anatomy and Histology at the College of Physicians and Surgeons in New York, and in 1879–80 went to Europe, where he studied Embryology at Cambridge under Professor Francis Balfour and Comparative Anatomy in London under Professor Thomas Henry Huxley. He later spent some time at Coburg, Germany, learning German. In 1881 he was appointed as the Assistant Professor of Natural Science at Princeton, and in 1883 as the Professor of Comparative Anatomy; this latter post he held till 1890. In 1891 he was invited to occupy the Da Costa Chair of Biology of the Columbia University for organising the Zoological Department of the University. He selected the first officers of the department and was responsible for the planning of the teaching and research work in Zoology in this institution. During this period he started the well-known Columbia Biological series of publications and was also responsible for the starting of a University Press at Columbia which has done such useful work in the cause of education. From 1892–95 he served as the Dean of the Faculty of Pure Science of the University. In 1910 he retired from active teaching at Columbia, but up to his death retained his connection with the University as the Research Professor of Zoology.

Henry Fairfield Osborn.

From 1891–1910 Professor Osborn, in addition, carried on active work as the Curator of the Department of Vertebrate Palæontology at the American Museum of Natural History. In 1910 he retired from the Curatorship of this section, but he continued to act as the Curator-in-chief not only of this division but also of the divisions of Mineralogy, Geology, Geography and Astronomy. In addition to being a trustee

of the American Museum of Natural History, he served as its Vice-President (1899–1901) and was its President from 1908 to the date of his death. During his Presidential administration he inaugurated a highly efficient plan for the internal organisation of the American Museum, and established its well-known series of publications of which the *Natural History* is a popular publication well known all over the world. During the period of his administration there has been a remarkable advance in the palæontological technique of the Museum, while the most important development for the instruction and recreation of the visiting non-scientific public has been the preparation and installation of attractive museum groups in replicas of their natural surroundings in almost all sections of the Museum. As a result of his incessant propaganda work he was able to raise sufficient funds for sending numerous expeditions in search of fossil vertebrates and for the collection of natural history material not only to different parts of America but almost all over the world. It was his far-seeing policy that has made the American Museum of Natural History one of the biggest institutions of its kind, with its very rich study collections for research, and the beautiful and instructive exhibits in its very extensive public show galleries. Such galleries as the Hall of Life of the Oceans, the African Hall of Mammals, the Asiatic Hall of Mammals, the wonderful groups of birds from different parts of the American continent, the marvellous restorations of fossil animals from different parts of the world, the groups illustrating the life and habits of the American Indians from different parts of the American continents contain beautifully arranged exhibits of high educative value. His work in the cause of public education was considered of so great an importance as to be acknowledged by the award of the Roosevelt Medal of Honour, presented by President Harding in 1923.

In 1900 President Osborn was appointed as the Vertebrate Palæontologist of the U.S. Geological Survey, and in 1924 he was promoted to the rank of its Senior Geologist. In 1903 he was unanimously elected as the Secretary of the Smithsonian Institution, the highest scientific post in the United States of America, but in view of his great interest in the American Museum of Natural History he declined this high honour.

His first scientific contribution was published at the age of 21, and since that date during the 58 years of his active life he published an enormous number of original contributions either in the form of papers and monographs or as separate volumes dealing with special subjects. Of these, special mention may be made of his outstanding monograph on *The Titanotheres of Ancient Wyoming, Dakota, and Nebraska* (1929), his monograph on the *Fossil Proboscidæ* (1932), *From the Greeks to Darwin* (1894), *The Age of Mammals* (1911), *Origin and Evolution of Life* (1917) and *Men of the Old Stone Age, their Environment, Life and Art* (1918).

His earlier work was devoted to studies on the evolution of mammalian teeth, as a result of which he prepared a descriptive nomenclature which has replaced the conflicting and confusing terminology of previous investigators and resulted in his theory of "determinate variations" in the evolution of organisms, which he called the "doctrine of rectigradation"; this is not to be confused either with the "orthogenesis" of Eimer, or with the "mutations" of de Vries. The same principle of hereditary ancestral control of variations he afterwards found illustrated by the origin and evolution of horns and other organs of vertebrates. His principles of adaptation were "neither theories nor hypotheses but facts clearly and repeatedly revealed by palæontological research," and these, according to Osborn, help to solve the riddle of the bio-mechanical origin of species. As a result of his detailed studies of the causes of evolution he enunciated his new principle of "tetraplasy" which he believed to be fundamental for the evolution of organisms. This principle of tetraplasy or "the law of the four inseparable factors of evolution" (1912) was formulated as follows: "The life and evolution of organisms continuously centre round the processes which we term heredity, ontogeny, environment and selection. These have been inseparable and interacting from the beginning. A change introduced or initiated through any one of these factors causes a change in all."

Amongst his Zoological contributions, reference may be made to his papers dealing with the "Brain of Amphiuma," the "Brain of Menopoma" and the "Internal Structure of the Amphibian Brain" (1883–1888). This work resulted in his detailed "Studies on the Brains of Amphibians, Reptiles and Birds" and led to the establishment of an

American School of Neurological Research by his students, of whom Strong and Herick deserve special mention. As he himself stated, the new biological principles which he enunciated as a result of an inductive line of investigation, have not been universally accepted, but the environmental principles of adaptive radiation, polyphyletic evolution and homogenic classification have gained wide support amongst Palæontologists and, to some extent, among Zoologists.

President Osborn was a member of a large number of scientific academies and societies, and was also the recipient of a large number of medals and awards both in the United States and of the leading scientific societies all over the world. He was a foreign member of the Royal Society of London and was the only Zoologist to be elected as an Honorary Centenary Member of the Asiatic Society of Bengal in 1934. The writer had the privilege of meeting him first in 1925 on the occasion of the Meeting of the British Association for the Advancement of Science in Oxford and later in New York in 1930, and can never forget the impression created by his masterful personality. President Osborn was a charming man, pleasant and unassuming to talk to, and his interest in anything relating to Science and Education was all-absorbing. May his soul rest in peace!

B. P.

[*Note.*—The writer of this notice acknowledges his indebtedness to Osborn's *Fifty-two Years of Research* (1930) for details in reference to his life.]

The Snakes of India: A Historical Review.*

By Beni Charan Mahendra.

(*Department of Zoology, St. John's College, Agra.*)

INTRODUCTION.

THE recent publication of Gharpurey's book[1] on the Snakes of India affords a suitable occasion to present a historical review of the main works[2] on Indian Ophiology published so far. Such a review, it is hoped, would not only help interested readers to select what they want in this line, but would also probably suggest to prospective authors the scope for new ventures. Smith's volume on the Indian Ophidia[3] is now in course of preparation, and the present review has thus the further advantage of preceding a work, which is expected to give a fresh stimulus to the study of this fascinating group of animals.

The history of Indian Ophiology falls naturally into four main periods: First, the *Pre-Scientific Period*, which extended from times immemorial to somewhere towards the end of the 18th century and comprised numerous scattered observations on Snakes (partly correct, but mostly erroneous) in the Hindu religious books and traditions; secondly, the *Initial Scientific Period*, which dawned with the interest in Ophiology of some early English officials in India and is mainly represented to us in the works of Patrick Russell; thirdly, the *Pre-Modern Period*, which was ushered in by Günther (1864) and extended up to the publication of Boulenger's *Reptilia and Batrachia* (1890); and lastly, the *Modern Period*, which extends from 1890 to date.

All these four periods overlap to some extent, and the division cannot, therefore, be regarded as a rigid one. For the purpose of the present review, however, we find it most convenient and we hope that further work would only bear it out.

PRE-SCIENTIFIC PERIOD.

As far as we are aware, there is no ancient Indian book dealing exclusively with Ophiology, but scattered here and there one often comes across a great many notions and allusions about Ophidians in the Hindu scriptures. One of the Vedas[4] has several verses about them, and both *Mahábhárata* and *Bhavishya-purána* have much in them that is interesting in this connection. Perhaps here one might draw attention to Shripád-Dámodar Sátavalekar's "वैदिक सर्प विद्या" and to Jayadeva Sharma's articles in *Vijnána*,[5] as also to Fayrer's address[6] to the Victoria Institute, to Fergusson's *Tree and Serpent-Worship*, and to Tylor's *Primitive Culture*.

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* The reviewer lays no claim to omniscience of the books published on Indian Ophiology. For the last nine years he has been interested in the subject and is acquainted with the more important literature. While he feels that he has not missed any important book on the subject he would be glad to know from readers whether any important publication has been omitted from the review.

[1] Gharpurey, K. G., *The Snakes of India.* Popular Book Depot, Grant Road, Bombay, 1935.

[2] With the exception of three series by Major Wall, which were published in the *Journal of the Bombay Natural History Society*, and which are, to all intents and purposes, books in their scope though not in their get-up and form, the present review is confined only to a survey of books and does not take notice of the numerous articles—taxonomic and otherwise—which appeared from time to time on Indian Ophiology in various scientific journals.

[3] Smith, Malcolm A., "*Reptilia and Amphibia*" (*Fauna of British India*), Vol. III (in course of preparation).

[4] *i.e.*, Atharvaveda.

[5] Jayadeva Sharma, "प्राचीन सर्पजन विद्या", *Vijnana*, **18**, pp. 8–12 and 74–79; "वेदमें सर्प विद्या", *Vijnana*, **18**, pp. 108–112.

[6] Fayrer, Joseph, *On Serpent-worship and on the Venomous Snakes of India.*

INITIAL SCIENTIFIC PERIOD.

This period is principally represented to us by two volumes, which are probably the first scientific approach to Indian Ophiology in the form of a book publication. The first volume of Russell's *Account of Indian Serpents, collected on the Coast of Coromandel*[7] was published in 1796, and the second in 1801–1809. Both these volumes contained brief descriptions and "carefully executed plates" of various Indian snakes, but it must be pointed out that Russell "applied only the vernacular names to his specimens,"[8] which is rather unfortunate as vernacular names are in most cases variable and have only a local application, especially in a country like India where the language of the people differs so much from place to place. As Malcolm A. Smith[9] points out, "native names are often unreliable, except for the commonest forms. The same species may have a different name in a different part of the country, even though the language has not changed, or the same name may be applied to two different species. After all, it is not to be wondered at, for the country people have no great interest in reptiles except for the few that enter into their dietary."[10]

Patrick Russell, however, "was the pioneer of Indian Ophiology. He was the first person in India to distinguish the harmless from the venomous snakes, which he did by a careful examination of their teeth; he made also many experiments with animals to discover the toxicity of their poison....... A number of his preserved snakes and his collection of dried skins, some of which are the specimens from which his drawings were executed, are now in the British Museum (Natural History). The dried skins are carefully mounted on strong paper, and many of them still show the living colours remarkably well. He died in London. A good account of his life, with a portrait will be found in the second volume of his *Indian Serpents*, which he did not live to complete."[11]

PRE-MODERN PERIOD.

In 1864, a general work by Dr. A. Günther appeared on *The Reptiles of British India*,[12] and it contained descriptions of 180 species of Indian Snakes, along with those of other Reptiles. The work was "founded on the earlier publications of Russell, Cantor, Gray, Blyth, Jerdon, Kelaart, and others, largely supplemented by the author's own researches;"[13] but its main contribution to Indian Ophiology lay in proposing a new classification which was readily accepted by many subsequent workers (sometimes, with alterations) and lasted till the publication of Boulenger's volume in 1890.

As pointed out by Malcolm A. Smith, "the term India at that time was used in a much wider sense than it is to-day,"[14] and the area included by Günther practically comprised all the South-eastern Continental Asia. Amongst the earlier workers on Indian Herpetology, Günther occupies a premier position, and it is with some regret that one notes the omission of an account of his life from the short, excellent biographical sketches of the "best-known Indian and Indo-Chinese herpetologists" that Malcolm Smith gives us in the Introduction[15] to the First Volume of his *Reptilia and Batrachia*.

Eight years after the publication of Günther's Monograph, Fayrer (1872) made an extremely valuable contribution to Indian Ophiology in the form of a large-sized volume entitled *The Thanatophidia of India*[16] and published by J. and A. Churchill, London. The volume opened with four quotations from Shakespeare, was dedicated to the Right Hon. the Earl of Mayo, Viceroy and Governor-General of India, and contained 31 large plates, all but three of which were beautifully coloured and represented artistically the natural appearance of Indian venomous snakes. The last three (uncoloured) plates showed the method of handling a snake, the muscular apparatus for erecting fangs, the poison glands, the head shields of a colubrin snake, diagrams of fangs, skull, etc.

Fayrer's aim was to make "reliable information on the Venomous Snakes of India" generally available and he modestly claimed that in his book "there is no pretension to novelty in the description of the snakes." He chiefly based his classifications and definitions on Günther, or on other authors of repute, and the anatomical descriptions on those of Owen and Huxley, but he had "carefully verified their descriptions by comparison with, and by careful dissections of the snakes themselves". Most of what he writes is authoritative, and probably that is due to a "close observation of the principal Indian forms of poisonous snakes during life, for a period of more than three years". His main interest lay in the physiological action of snake venoms, and he performed 29 excellent series of scientific experiments *on the influence of snake poison on the lower animals, and on the value of certain modes of treatment and reputed antidotes*,[17] which have not so far been surpassed.

To say that Fayrer was an influential man is putting the matter too mildly. He was Honorary Physician to the Queen, Surgeon-Major, H. M. Bengal Army, Professor of Surgery and Senior Surgeon in the Calcutta Medical College and its Hospital, Fellow of the University of Calcutta, a President of the Asiatic Society of Bengal, F.R.S., F.R.S.E., and C.S.I. His position gave him many facilities in the way of Ophiological research that are denied to lesser men,

7 Russell, P., *An Account of Indian Serpents, collected on the Coast of Coromandel*. 2 Vols. London, 1796-1801 (known to the reviewer through Malcolm A. Smith's description).

8 Smith, Malcolm A., *Fauna of British India, Reptilia and Amphibia*, 1931, **1**, 3.

9 *Op. cit.*, pp. 1–2.

10 The reasoning is not very plausible. The country people of India are interested, for instance, in the Cobra, the Uromastix, the sacred Turtle of Jamuna, but none of these animals forms part of their dietary.

11 Smith, Malcolm A., *op. cit.*, p. 3.

12 Günther, A., *The Reptiles of British India*, pp. 444, 26 pls., London (known to the reviewer through Boulenger's description).

13 Boulenger, G. A., *Fauna of British India, Reptilia and Batrachia*, 1890, London, p. iv.

14 Smith, Malcolm A., *op. cit.*, p. 2.

15 Smith, Malcolm A., *op. cit.*, pp. 3-13.

16 Fayrer, J., *The Thanatophidia of India, being a description of the Venomous Snakes of the Indian Peninsula, with an Account of the Influence of their Poison on Life and a series of experiments*, J. & A. Churchill, London, 1872.

17 Fayrer, J., *op. cit.*, Section V, pp. 63-145.

and he was not a person to forego opportunities. By having an official circular sent round by the Inspector-General to Deputy-Inspectors-General of Hospitals, he collected an imposing array of cases of snake-bites with valuable data.[18] He addressed letters to the Secretaries or Political Agents of Bengal, North-West Provinces, Punjab, Oudh, Central Provinces, Central India, Rajputana, and British Burmah, and collected statistics about deaths from snake-bites, which are really imposing.[19] After a careful study of all the methods of treatment of snake-bite available in his days, he gave in his book an excellent account of the subject, together with "suggestions for the immediate treatment of persons bitten by venomous snakes".[20] *The Thanatophidia* ends with 8 appendices, the third of which contains an account of the use of snake-venom in Áyurveda (*i.e.*, "by the Kabirajes of Bengal"), and the fourth with the four classes of snake-charmers found in Bengal.

Besides this monumental work, Fayrer was a frequent contributor to the *Proceedings of the Royal Society* on matters pertaining to Indian Ophiology, and it is interesting to note that he, in collaboration with Brunton, was the first to discover the antidotal power of permanganate of potash and chloride of gold in cases of snake-bites.[21] Some of his papers, originally published in 1873–1904, were collected together by Brunton and reprinted in the form of a book[22] in 1909.

Fayrer's *Thanatophidia*, though a first-rate contribution to Indian Ophiology, is unfortunately large, unwieldy and expensive, and thus it was felt necessary to issue a shorter work which might be treated as a hand-book by "the busy officials of India" for the recognition of any of the poisonous snakes of this region. This was the occasion for a smaller volume by Ewart,[23] which contained 21 coloured plates of snakes borrowed from Fayrer, a short introductory chapter on "Symptoms and Treatment of Snake-Poisoning," concise accounts of the more important venomous snakes and a glossary at the end to help the layman to a meaning of the words used.

In 1874, Nicholson published a small book on *Indian Snakes*,[24] which—though not so imposing as Fayrer's work—is full of valuable information and original observations. Nicholson was a keen student of Indian Ophiology and loved to study the snakes and their ways as much in their natural surroundings as in a museum. He started to give the readers a hand-book of Indian Snakes, and he succeeded in producing a volume which is certainly true to the sub-title *An Elementary Treatise on Ophiology*. Beginning with a short introduction assigning the proper place to Ophidia in the scheme of scientific classification, he proceeds to deal in the First Part of his book, with the anatomy of this group of animals. The skeleton, the mouth and teeth of harmless and venomous snakes, the internal organs, the senses and the integument are all treated concisely though clearly, much of the material probably having been derived from Owen and Schlegel. In the Second Part of his book, he classifies the Indian Ophidia, gives a Phylogenetic Tree based on his own studies, and describes the Indian forms carefully. The Third Part deals with the natural history of snakes and does much credit to Nicholson's interest in Indian Ophiology. His chapters on "The Snake at Liberty," "The Serpentarium," "Schemes of Extermination," and "Snake Mythology" are full of original matter, and some of them, at any rate, must have necessitated much thought and patient observation. It appears that not satisfied merely with the study of preserved specimens, Nicholson used to keep live snakes with him and to observe them carefully, besides going out snake-hunting off and on. In the chapter on "Museum" he gives valuable information for the preservation of specimens and other allied matters, and in that on "Snake-Poison and Antidotes" he adds some information of his own to a survey of what was already known on this subject.

One feels tempted to make an interesting quotation from Nicholson, partly because it forms really good advice and partly also because it gives us a clue to the mentality of this author. He says,[25] "From the eagerness of people to look for the marvellous in all that concerns snakes, the observations of non-scientific enquirers are always open to suspicion. On this subject, the safest plan is to believe nothing that you hear, and only half what you see yourself, guarding carefully against the liability of your visual impressions being influenced by your expectations and pre-conceived ideas."

Two years after the publication of Nicholson's work and twelve years after that of Günther's, another general work[26] on the Reptiles of British India appeared with the object of meeting "a want which......blocks the way to the general study of Herpetology in India, and to supply in an accessible and portable form such a condensed description of our Indian Reptiles as may enable any one interested in the Fauna of his locality to acquaint himself with the Reptiles he meets with." Theobald's *Descriptive Catalogue of the Reptiles of British India* was based on Günther's work, but it excluded 'Hydrophidæ' and the 'Batrachia' from its scope, and restricted itself to British India alone. To a great extent, it was "virtually an abridgment of Günther's, but with the numerous discoveries and observations of Stoliczka, Beddome, Anderson, and of the author himself added to those of Günther,

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18 Fayrer, J., *op. cit.*, Section IV, pp. 42-62.

19 Fayrer, J., *op. cit.*, Section II, pp. 30-36.

20 Fayrer, J., *op cit.*, Section III, pp. 37-41.

21 Brunton, T. Lauder and Joseph Fayrer, "*Note on the Effect of Various Substances in Destroying the Activity of Cobra-Poison*" (*Proc. Roy. Soc.*, 1878, **27**, 465): "*Experiments on a Method of Preventing Death from Snake Bite, capable of Common and Easy Practical Application*" *Proc. Roy. Soc.* 1904, **73**.

22 "*On the Poison of Venomous Snakes and the Methods of Preventing Death from their Bite.*" (Reprinted Papers by Joseph Fayrer, Lauder Brunton, and Leonard Rogers.) Macmillan, London, 1909.

23 Ewart, *Poisonous Snakes of India.* (Year and place of publication not known.)

24 Nicholson, Edward, *Indian Snakes: An Elementary Treatise on Ophiology.* Higginbotham & Co., Madras, **1874** (Second Edition).

25 Nicholson, Edward, *op. cit.*, p. 125.

26 Theobald, William, *Descriptive Catalogue of the Reptiles of British India.* Thacker, Spink & Co., Calcutta, **1876**.

many additions by the latter having been made after the publication of his large work on Indian Reptiles."[27] It contained descriptions of 225 species of Ophidians, while Günther's Monograph —in spite of the larger geographical region that it dealt with—had described only 180 species.

Theobald's book is deficient in illustrations, there being only two on page iii of the Appendix, and his descriptions do not aim to be exhaustive, but include, as he says, "only so much detail ......as will enable the student to specifically determine" any species. Following 4 pages of "Errata et Addenda," the text concerns itself with systematic descriptions of the orders, families, genera and species of various reptiles, 126 pages being devoted to the order Ophidia. A list of non-Indian species included in Günther's Monograph is given, as also an Index of the Genera and species of Indian Reptiles and a Key for their identification. The book ends with an Appendix dealing with "the means of discriminating between poisonous and harmless snakes and the treatment of snake-bite."

Much work has been done on Indian Ophiology after Theobald, and thanks to the labours of Major Wall, we have now a better key for the distinction of venomous[28] from non-venomous snakes. Still, however, the following advice by Theobald bears reiteration: "Perhaps, the simplest way of learning what are poisonous snakes, would be to pass an hour or so in some museum where acquaintance might be made with the commoner or more deadly species."[29] After all, both Boulenger's[30] method of the examination of dentition and Colonel Wall's of scrutinising the scales are applicable only to dead specimens and fail when the snake is fully alive and vigorous. Then it is *only* Theobald's advice which might be of some use. We have to know the poisonous snakes individually in order to be able to pronounce judgment on live ones.

MODERN PERIOD.

The modern period in Indian Ophiological research begins with the publication of Boulenger's volume on *Reptilia and Batrachia*[31] in 1890. Boulenger was already famous for the laborious Catalogues[32] of the Reptiles in the British Museum that he had prepared, and he had made his mark as a first-rate herpetologist. His volume on Indian Reptiles and Amphibians was readily accepted as a standard work, and although a number of the species described by him have undergone changes in the light of further work, his book still forms the basis of taxonomy about these animals. He gave us a new classification for the Ophidia, a classification which is regarded by most Ophiologists as "a logically-conceived system, by far the best hitherto proposed,"[33] and which has been implicitly followed by later workers. The previous classification of the Ophidia was due to Günther, and consisted essentially in the division of this Order into 21 families, arranged into four suborders: *Hopoterodontes, Colubriformes, Colubriformes venenosi, Viperiformes.* Boulenger, however, recognised only 9 families and assigned the rank of sub-families to several previously called families. The section on Ophidia in his book contains descriptions of 264 species and occupies 200 pages.

Starting with an extremely short introduction about the Ophidia (pp. 232–33), mainly concerned with the characteristic peculiarities of the order and with remarks upon the distinction between poisonous and non-poisonous snakes, the poison-glands and fangs, he gives a Synopsis of the Families, followed by systematic descriptions. The section on Ophidia is illustrated with 59 carefully-drawn figures. As pointed out in the Preface, "the classification of the Snakes, which comprises nearly one half of the Reptilian species known to occur in India, is new, and all the descriptions of families, genera, and species have been prepared expressly for the present work. As there is no recent publication with a complete synonymy of the Ophidia, somewhat fuller references to the literature of the subject have been rendered necessary than in the other suborders of Reptiles and Batrachians."[34]

Boulenger's volume, apparently designed for the scientist, is written in such a compact and concise manner as not to be of much use for the layman. His descriptions of species and genera are models of compression, and he does not explain the terms that he uses. The lengths mentioned in the description of the species are apparently the maximum that he found, and he notes the habitat of each species that he records.

In 1891, Sclater published a *List of Snakes in the Indian Museum*,[35] a book containing x + 79 pages and giving no descriptions of any species at all, but only details about the place and date of collection, the name of the collector, etc., of the Ophidian specimens then in the Indian Museum. Under the name of each species is given the name of "the Author of the specific name and a reference to the best description, not necessarily the original one, to which" the author had "been able to get access". Sclater adds 14 more species to those described by Boulenger, and gives a list of those species of snakes which were not in the Indian Museum.

From 1895 to 1925, we find an indefatigable

[27] Boulenger, G. A., *Fauna of British India* (*Reptilia and Batrachia*), 1890, p. iv.

[28] Owing to M. Phisalix and Caius's work, we now know that almost all snakes are poisonous—to their legitimate prey, and so the word 'venomous' or 'poisonous' is now understood to mean 'poisonous to man or higher animals'. (See Prater, S. H., "*Non-poisonous Snakes*" in *Jour. Bom. Nat. Hist. Soc.*, 1933, **36**, 391-394.

[29] Theobald, William, *op. cit.*, p. ii (Appendix).

[30] Boulenger, G. A., *Fauna of British India*: *Reptilia and Batrachia,* 1890, p. 233 (Boulenger, however, is not the discoverer, but an exponent of this method).

[31] Boulenger, G. A., *Fauna of British India*: *Reptilia and Batrachia*, London, (1890).

[32] Boulenger, G. A., *Catalogue of the Chelonians, Rynchocephalians, and Crocodiles in the British Museum* (*Natural History*), 1889. *Catalogue of the Lizards in the British Museum* (*Natural History*), Vols. I-III, 1885-7. *Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the Collection of the British Museum*, 2nd Edition, 1882. *Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum* 2nd Edition, London, 1882.

[33] "*Snakes*", *Encyclopædia Britannica*, 1911, **25**, pp. 288 ff. (Hans Gadow).

[34] Boulenger, G. A., *Fauna of British India* (*Reptilia and Batrachia*), Preface by W. T. Blanford, p. iv.

[35] Sclater, W. L., *List of Snakes in the Indian Museum*, Calcutta, 1891.

worker in the person of Colonel Frank Wall in the cause of Indian Ophiology. "He collected in all parts of the Indian Empire, and by his energy and enthusiasm stimulated others to make collections for him. For many years he has been the chief authority on Indian snakes. He visited in turn every museum in India and overhauled their collections. He was a prolific writer, and managed to combine admirably the scientific and popular sides of the subject. He was a constant contributor to the *Journal of the Bombay Natural History Society*, but wrote also for other Indian journals. The types of the numerous snakes described by him, together with many other specimens, are in the British Museum (Natural History); the rest of his collections are in the museums in India, principally in Bombay."[36]

It is beyond the scope of the present review to make a survey of even the more important contributions of Colonel Wall to Indian Ophiology, but we have selected three series of his, published in the *Journal of Bombay Natural History Soci ty*, for inclusion here.

A Popular Treatise on the Common Indian Snakes[37] was published from 1905–1914, and ran into as many as 23 parts. It was copiously illustrated both with coloured plates and diagrammatic figures throughout, and must have necessitated patient research and close observation on Indian snakes for many years. Unfortunately the Bombay Natural History Society has not so far published it as a separate book, in spite of the fact that there is a general demand for such work.

The series begins with the intention of acquainting the readers with the common snakes of India and it fulfils its purpose remarkably. As the author himself says, "there is no book on the subject written in popular language, and the few that show coloured plates are very expensive, while accuracy of detail seems to have been largely sacrificed for pictorial effect.... The descriptive parts of the best works are couched in terse and scientific language, and though excellently written by experts in museums the authors have had no facilities for observing the habits of creatures they only see in spirit on museum shelves. We must, therefore, rely upon those who actually come into contact with living snakes to supply such information."[38] Wall's series supplies such information to a very great extent.

The whole series is excellently written to evoke popular interest and within its scope, has not been surpassed up to the present time. Wall takes one species after another, and like an adept scientific snake-charmer, gives particulars about nomenclature (scientific, English and Vernacular), dimensions, bodily configuration, colour, identification, haunts, disposition, food, breeding habits, and what not. One often wonders at the amount of knowledge he has garnered, and admires his clear mode of expression.

In 1906, appeared a much shorter series by Wall: *The Poisonous Snakes of India and How to recognise them*;[39] and this series was later published in the form of a book[40] in 1908, with many alterations and changes. The book is an authoritative contribution to the subject and so far as we know, has already passed through 4 editions. Wall prepared a key [41] for the identification of poisonous from non-poisonous snakes in 1902, and the fact that the key met with much favour and was even circulated by the Inspector-General of Civil Hospitals in the Central Provinces, seems to have encouraged him to write this series.

A third series[42] by Colonel Wall, entitled *A Hand-list of the Snakes of the Indian Empire*, was written for the field naturalist, and set out to enumerate all the species of Indian ophidians known at that time, besides giving such details as type, length, lepidosis, distribution, etc., in a concise manner. It serves as a good supplement to Boulenger's work, and makes the taxonomic work of later years accessible to the reader.

In 1914 was published a much less pretentious book by Cazaly,[43] only 60 octavo pages in extent and designed to help the layman to an identification of the commoner snakes of India. The book is written in extremely simple language, does not claim to add anything new in the form of facts, and relies for its information on Nicholson's *Indian Snakes* and Wall's *Poisonous Snakes*, and for names on Boulenger's *Catalogue of Snakes*.

In 1919, Roberts[44] made a curious collection of the details of the *remedies that are employed by the native physicians of Ceylon and India in the bites of snakes and other animals, and in the stings of animals*. Although we cannot support the use of these medicines as there is no scientific backing for them, we have been much interested in the book itself, and especially in the specimens of "magical spells"[45] given in it.

D'Abreu's *The Snakes of Nagpur* (1916),[46] Wall's *The Snakes of Ceylon* (1921),[47] and Prater's *The Snakes of Bombay Island and Salsette* (1926),[48] are all restricted in the geographical area that they deal with, but are good in their own spheres.

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36 Smith, Malcolm A., *op. cit.*, **1**, pp. 12-13.

37 Wall, Captain F., "*A Popular Treatise on the Common Indian Snakes.*" (*Jour. Bom. Nat. Hist. Soc.*, 1905, **16**, 533-554, (Part I); 1914, **23**, 206-215 (Final, *i.e.*, **23** pt.)

38 *Jour. Bom. Nat. Hist. Soc.*, 1905, **16**, 533.

39 Wall, Capt. F., "*The Poisonous Snakes of India and How to Recognise Them.*" (*Jour. Bomb. Nat. Hist. Soc.*, **17**, 51-71, 299-333).

40 Wall, Col. F., "*The Poisonous Terrestrial Snakes of our British Indian Dominions (including Ceylon) and How to Recognise them with Symptoms of Snake Poisoning and Treatment*" [*Bomb Nat. Hist. Soc.*, Bombay, 1908 (1st ed.); 1917 (3rd ed.); 1928 (4th ed.)]

41 Wall, Capt. F., "*The Distinguishing Characteristics between Poisonous and Non-Poisonous Snakes*" (*Jour. Bomb. Nat. Hist. Soc.*, 1902, **14**, 93-102.)

42 Wall, F., "*A Hand-List of the Snakes of the Indian Empire*" [*Jour. Bomb. Nat. Hist. Soc.*, 1923-4, **29**, 345-361. (Part I); pp. 598-632 (Part II); pp. 864-878 (Part III); 1924-25, **30**, pp. 12-24 (Part IV); pp. 242-252 (Part V)].

43 Cazaly, W. H., *The Common Snakes of India and Burma and How to Recognise Them.* Pioneer Press, Allahabad, **1914**. This has only **11** figs.

44 Roberts, Emmanuel, *Native Remedies used in Snake Bites, etc.*, H. W. Cave & Co., Colombo, **1919**.

45 Roberts, Emmanuel, *op. cit.*, p. ix.

46 D'Abreu, E. A., *The Snakes of Nagpur*, Government Press, Nagpur, **1916**.

47 Wall, Col. F., *The Snakes of Ceylon*, **1921**.

48 Prater, S. H., "*The Snakes of Bombay Island and Salsette*" [*Bomb. Nat. Hist. Soc.*, 1926].

In 1923, Wall gave us an invaluable book on the *Identification of Indian Snakes*,[49] full of keys and synopses that have proved almost infallibly useful to the reviewer for the last 9 years and represents a laborious research on the part of the author for very many years. Wall says, "In my early days in India when I began to take up the study of snakes I found it extremely difficult to find out the names of the commonest specimens I encountered. The books on the subject then available gave little, if any, help to one like myself a beginner. The keys given to assist the student were very unsatisfactory, being too scientific. Often indeed one had to investigate difficult points which called for skilled dissection, points concerning peculiarities in the dentition, or even the more difficult matter relating to processes such as those of vertebræ. Very few men in India have the inclination or skill necessary to investigate such points, still fewer have leisure hours sufficient to undertake such a laborious and difficult task. In consequence many with a natural bent for biological research are deterred from taking up a subject which would provide endless interest, and pleasure, especially to men who are often alone in camp, on tea and coffee plantations, or who have joined the Indian Forest and other services."[50] For such people and others, even for workers in museums, Wall offers the fruits of his labours in this book, and we are sure that an identification arrived at by his methods, if confirmed later by a reference to Boulenger's work or some other standard volume, would be unimpeachable.

Wall's keys and synopses are based on a study (mostly statistical) of the scale characters of Indian ophidians, and as he himself points out, they have been assailed on the ground that they "are not natural ones, but what some reviewers of" his "past work term 'unscientific'. The only drawback we find in them is, that they give no idea about Ophidian *genera*, and especially in the case of such a family as *Colubridæ*, not only bring together forms that are believed to be much apart from each other, but also separate allied species from one another. In some cases the same species (*e.g.*, *Coluber helena*, *Zamenis arenarius*, *Naia tripudians*, etc.) occupies two or more different positions in the same synopsis.[51] Besides, in a chart like that for the genus *Silybura*[52] or *Rhinophis*,[53] too much stress has apparently been laid on the relative proportions of the head shields and little allowance made for the play of individual variations that one is apt to find so often in nature.

In 1929, a rather large book appeared "from the pen of a layman," Paresh Banerji,[54] which was not really a contribution to Indian Ophiology, but a sort of advertising campaign by the writer in favour of a specific ("Lexin") that he claimed to have invented for snake poisoning. The book was, on the whole, well published and had several coloured plates of Indian snakes; but unfortunately, a greater part of it was devoted to substantiating the 'efficacy' of the 'supposed' snake specific, and it contained as many as 1134 reports of cases in which Lexin was said to have cured snake-bites.

This brings us to the latest book published on the subject: that by Gharpurey (1935), which is a popular contribution to Indian Ophiology, and is written with the object of enabling laymen to distinguish poisonous from harmless snakes and of giving information about the common forms met with in India. The author claims an interest "in the subject for over 25 years, being drawn to it mainly by the heavy mortality figures," and he has drawn largely for his materials on such standard books as those by Wall, Fayrer, Nicholson, etc. He modestly says, 'that there is hardly anything original in this book," but still he has made careful compilation of a huge amount of information about Indian snakes and he has presented his subject in a simple and lucid manner.

CONCLUSION.

In spite of much good work done on Indian Ophiology in the past, there is still a great deal of scope for further investigations in this subject, and it is hoped that more and more workers would take an active interest in it and add their contributions. True it is, that "systematic collecting has been carried out in nearly all parts of the Indian Empire, and, except in the more inaccessible mountain districts, the herpetological fauna of the country is now pretty well known."[55] But "in the exact distribution of the species, in their individual variation, in habits, life-histories, in fact in bionomics generally, a vast amount of investigation has still to be done," although "for the mere collector in search of new species no great field remains."[56]

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49 Wall, Colonel F., *How to Identify the Snakes of India (including Burma and Ceylon)*, 1923.

50 Wall, *op. cit.*, Preface.

51 Wall, *op. cit.*, pp. 23 38.

52 Wall, *op. cit.*, pp. 13-16.

53 Wall, *op. cit.*, p. 17.

54 Banerji, Paresh, *Hand-book of Snake-bite*, P. Banerji, Mihijam (India), 1929.

55 Smith, Malcolm A., *Fauna of British India: Reptilia and Amphibia*, 1931, 1, 1.

56 Smith, Malcolm A., *op. cit.*, p. 1.

Research Notes.

Theory of Meromorphic Functions.

LARS AHLFORS ("über erine Methode in der Theorie der Meromorphen funktionen," *Com. Phy.-Math.*, T. **8**, Nr. 10) has contributed a valuable paper on the introduction to the theory of meromorphic functions. After the fundamental contribution of Rolf Nevanlinna characterised by his first two fundamental theorems, the introduction was simplified in two directions. One was due to the Japanese workers headed by Shimuzu and the other was due to the Finnish school headed by Selberg and Frithiof Nevanlinna. Combining and crystallising all these methods the author has proved the chief properties of the characteristic function $T(r)$, and has deduced the second fundamental theorem of Nevanlinna in 14 pages. The ideas underlying the contribution are these:—First of all $m(r, a)$ is defined to be

$$\frac{1}{2\pi}\int_0^{2\pi}\log\frac{1}{\{f,\ a\}}\,d\theta$$

where $f(z)$ is the meromorphic function and (a, b) denotes the straight-line distance between the stereographic projections of a and b on a sphere of diameter unity touching the plane at the origin. (This is essentially the same as the earlier definition of Nevanlinna.) $N(r, a)$ is defined to be the same. Next by a simple differentiation and applying the principle of argument the independence of $T(r, a)$ w.r.t. a is deduced. There is no need to apply the Poisson-Jensen formula at all. Next taking $\rho(a)$ to be any positive function such that $\oint \rho(a)\,d\omega(a)$ taken over the surface of the sphere $= 1$, he has shown in a single step that if

$$m_\rho(r) = \oint m(r,\ a)\ \rho(a)d\omega(a) \text{ and } N_\rho(r) = \oint N(r, a)\ \rho(a)d\omega(a).$$

then $T(r) = m_\rho(r) + N_\rho(r)$ also. From this he has easily deduced the convexity of $T(r)$ w.r.t. $\log r$. This is extremely simple when we remember the fact that this is proved by Nevanlinna by making use of the properties of the Green's function corresponding to a ring-region. The second fundamental theorem of Nevanlinna is obtained as a corollary of this result by taking a suitable density function $\rho(a)$; *viz.*,

$$\operatorname{Log}\ \rho(f) = c + 2\sum_1^q \operatorname{Log}\frac{1}{\{f,\ a_\nu\}} - \alpha\log\left[\sum_1^q\log\frac{1}{\{f,\ a_\nu\}}\right]$$

where c is a normalising constant and α is any number > 1. Some words are to be said with respect to the form of the theorem we obtain when we consider functions meromorphic in the unit circle. We get

$$\sum_1^q m(r,\ a_\nu) < 2T(r) - N_1(r) + \log T(r) + k'\log\frac{1}{1-r} + 0\ (1)$$

except in a set of intervals I_t such that $\Sigma\int_{I_t}\frac{dr}{(1-r)^{1+\epsilon}}$ is finite, k' being a constant which can be made as near to unity as we like. This is much sharper than the corresponding theorem by Nevanlinna and others and in fact as sharp as the result obtained by F. Nevanlinna by the use of suitable modular functions.

The second fundamental theorem mentioned here is not the *proper*—Nevanlinna by applying his *proper* second fundamental theorem in connection with his proof of Picard-Borel theorem. The proper theorem itself is applied by Nevanlinna to deduce further theorems, such as the theorems of unicity, etc. Probably these theorems can all be deduced directly by Ahlfors's method, but the proper theorem itself can be proved by Ahlfors's method as follows. Take

$$\rho(f) = k\frac{1}{\{f,\ \infty\}^2\{f,\ 0\}^2}\left[-\log\frac{\{f,\ \infty\}}{\{f,\ 0\}}\right]^{-\alpha}$$

where $\alpha > 1$ and k is the normalisation constant. After some further analysis it can be proved that

$$m_r\left[\frac{f'}{f},\infty\right] \leqslant \tfrac{1}{2}\log\left[\lambda(r)\right] + \alpha\log T(r) + 0\ (1)$$

where $\log\lambda(r) = 0[\log r + \log\ T(r)]$ except in the exceptional intervals. It should also be mentioned that this is the sharpest form in which the theorem is put. In fact if we work out the values of the actual constants we get a much sharper form than that obtained recently by Shimuzu and others.

K. V. I.

Uniform Distribution of Points.

KOKSMA ("Ein mengen theoretischen Satz uber die Gleich-verteilung modulo Eins.," *Comp. Math.*, **2**, Fasc. 2, pp. 250–258) has

recently contributed an interesting theorem concerning the uniform distribution of points $\{\theta^n\} = \theta^n - [\theta^n]$ (*i.e.*, the fractional part of θ^n.) He has proved that the distribution of such points is uniform in (0, 1) for almost all $\theta > 1$ (*i.e.*, excluding a set of points of measure zero utmost.) The most important theorem he proves in this connection is the following:—Let α and β be real numbers $\alpha > \beta$. Let $f(x, \theta)$ be a real continuous function of θ in $\alpha \leqslant \theta \leqslant \beta$ for every +ve integral value of x. For every $x_1 \neq x_2$, let $\phi(x_1, x_2, \theta) = f(x_1, \theta) - f(x_2, \theta)$ be a continuously differentiable function of θ (*i.e.*, its differential derivate ϕ_θ' is monotomic and $\neq 0$. Let

$$A_N = \frac{1}{N^2} \sum_{x_1=2}^{N} \sum_{x_2=1}^{x_1=1} \text{Max} \left[\frac{1}{|\phi'_\theta(x_1, x_2, \alpha)|} \frac{1}{|\phi'_\theta(x_1, x_2, \beta)|} \right]$$

and N_ν be a sequence such that ΣA_{N_ν} converges and $\frac{N_{\nu+1}}{N_\nu} \to 1$. Then $\{f(n, \theta)\}$ is uniformly distributed for almost all θ. The proof of this theorem is established by utilising Weyl's criterion, *viz.*,

$$\frac{1}{N} \sum_{1}^{N} e^{2\pi i f(n, \theta)} \to 0 \text{ with } N \to \infty.$$

From this the result follows as a particular case.

K. V. I.

Creation of the Radio-Elements belonging to a New Radioactive Family.

So far there were only three radioactive families known namely (1) the thorium series with atomic weights of the form $4n$ where n is an integer, (2) the radium series with mass numbers expressed by $W = 4n + 2$ and (3) the actinium series with $W = 4n + 3$. A series of the form $W = 4n + 1$ must consist of unstable elements since they do not occur normally in nature. Now I. Curie, H. von Alban Jr. and P. Preiswerk (*Journ. de Physique*, 1935, **6**, 361) have artificially produced some elements which they have definitely proved to belong to this family. Since Fermi has shown that slow neutrons have a large probability of being captured by a nucleus resulting in the formation of an isotope having the mass number greater by one, they bombarded Thorium with slow neutrons. The new element formed was expected to be β-active and hence to prove its existence, the Thorium had to be carefully purified to remove the radiothorium associated with it. After addition of Ba and Pb and Bi and precipitation with H_2SO_4 and H_2S respectively, La was added and the Thorium precipitated with H_2O_2. The hydroxide formed was converted into nitrate or chloride and dried before irradiation. The Thorium was placed in a bakelite case with a cellophane covering since such a case was found to be free from activity when irradiated. The β-activity was examined by means of a Geiger-Müller counter of thin aluminium 0·2 mm. thick. The activity curves were analysed and showed products of 1 min., 25 min. and 3·5 hrs. periods. These were chemically separated and then the repetition of the analysis showed two new products of periods 2·5 min. (associated with the 25 min. product) and 12 min. When the irradiated thorium was precipitated with H_2O_2, the 25 min. product came down with it showing that it is an isotope of Thorium. Addition of paraffin with consequent slowing down of the neutrons increased the yield of this product thus confirming the above view.

The 3·5 hrs. product accompanied La in the chemical separation thus showing itself to be an isotope of actinium. The 2·5 min. product was shown to arise from a Thorium isotope and to be an isotope of protactinium and hence the conclusion was drawn that the 2·5 min. product was produced from the 25 min. product. The several results could be explained on the basis of the following equations:

$${}^{232}_{90}\text{Th} + {}^{1}_{0}n = {}^{233}_{90}\text{R (25 min.)}$$

$${}^{233}_{90}\text{R (25 min.)} \xrightarrow{\beta} {}^{233}_{91}\text{R (2·5 min.)}$$

The production of the 1 min. product which was shown to be an isotope of radium was explained as follows:

$${}^{232}_{90}\text{Th} + {}^{1}_{0}n = {}^{229}_{88}\text{R (1 min.)} + {}^{4}_{2}\text{He}$$

$${}^{229}_{88}\text{R (1 min.)} \xrightarrow{\beta} {}^{229}_{89}\text{R (3·5 hrs) (isotope of actinium)}$$

The 12 min. product probably results from the process:

$${}^{232}_{90}\text{Th} + {}^{1}_{0}n \to {}^{232}_{89}\text{R} + {}^{1}_{1}\text{H}.$$

Thus the new radioactive family is probably developed thus:

$${}^{237}_{92}\text{R} \xrightarrow{\alpha} {}^{233}_{90}\text{R (25 min.)} \xrightarrow{\beta} {}^{233}_{91}\text{R (2·5 min.)} \xrightarrow{\beta} {}^{233}_{92}\text{R} \xrightarrow{\alpha} \text{etc.}$$

A search for the origin of this family ${}^{237}_{92}\text{R}$ in Uranium minerals was however without result.

T. S. S.

Electrets.

M. EGUCHI performed a remarkable experiment in 1925. A suitable wax was poured in the molten state into a condenser, a voltage was applied, and the wax allowed to solidify under the electric stress. The result was a permanently electrified body, an "electret," which retained its charge constant over a period of more than a year. In a recent paper (*Phil. Mag.*, 1935, **20**, 929) A. Gemant has carefully studied these highly interesting electrical analogues of permanent magnets, and finds that there are two possible kinds of charges, one having the opposite sign to the adjacent polarising electrode, of short duration, and caused by ionic space charges. The other has the same sign as the adjacent polarising electrode. It is caused by orientation of dipole molecules leading to an oriented crystallisation and accompanied under circumstances by a secondary piezo electric effect. This charge is the steady one, and is of great interest. Technical applications for such electrets can be found in the construction of electrometers and in a kind of electrostatic microphone.

M. A. G. RAU.

The Hammersten Effects.

J. W. McBAIN (*J. Am. Chem. Soc.*, 1935, **57**, 1916) has cleared up much of the confusion that has arisen by calling different Phenomenon "Hammersten Effect". Linderstörm-Lang conferred the name to the fact that the osmotic coefficient of the thymonucleates depends upon the size of the kation. Pauli and Valko and later others, included under this term the fact that in certain colloidal electrolytes the osmotic coefficient (obtained from freezing point lowering) is far less than that necessary to account for the hydrogen ion alone as measured by the electromotive force. McBain classes the former as the genuine Hammersten Effect and has put forth a new explanation of the same based on steric hindrance to close packing. The second phenomenon (the "Hammersten Effect" of Pauli) appears to be more fundamental in view of the considerations of McBain. The divergence between the freezing point and the electromotive force data finds a rational explanation on the basis that the activity coefficient of the hydrogen ion is about half of that of the chloride ion in the concentrated solutions of hydrochloric acid. This marks one of the very first steps in getting at the individual activity coefficients of the ions without making any arbitrary assumptions.

K. S. G. D.

The Use of Ortho-para Hydrogen Conversion in the Detection of Free Radicals.

THE fact that paramagnetic substances can catalyse the ortho-para conversion of hydrogen has been used for the first time in the detection of free radicals by W. West (*J. Am. Chem. Soc.*, 1935, **57**, 1931). He finds definite indications of the production of paramagnetic free radicals on illumination of methyl iodide and acetone. On the other hand, propionyl iodide does not seem to give rise to free radicals under similar conditions. This is pointed out as a strong evidence in support of Norrish's hypothesis of a difference in mechanism in the photo-dissociation of aliphatic aldehydes and ketones.

K. S. G. D.

Deuterium as an Indicator in the Study of Intermediary Metabolism.

IN a series of four papers published in the *Journal of Biological Chemistry* (1935, **111**, 163–192), Rudolf Schœnheiner and D. Rittenberg have published the results of their work on intermediary metabolism, employing a very elegant and novel technique. The difficulty of following the course of transportation of normal physiological substances in the body and their conversion into other substances has long been realised and very often laborious experiments have yielded uncertain results. While the use of synthetic derivatives for following the metabolism of physiological substances has yielded interesting results, the method is open to the objection that such derivatives are not natural, and it is open to doubt whether they successfully imitate the physiological substances whose metabolism is under investigation. By replacing one or more of the elements in the molecule of the substance, by their respective isotopes, it is reasonable to expect that the chemical properties of the substance will not be greatly altered. Schœnheiner and Rittenberg have employed this method and by replacing the hydrogen in the organic compound by its heavy isotope, deuterium, which is capable of being detected with a precision of 0·001 per cent. they are enabled to follow the fate of such substances after administration to animals. The employment

of deuterium as an indicator opens out a new chapter in the study of metabolism.

For a successful working of the method, the deuterium should be placed in the molecule in such a position that it is not interchangeable with the hydrogen of water. It was, therefore, necessary to introduce deuterium into carbon groupings by catalytic hydrogenation of unsaturated compounds. The application of the method is, therefore, restricted to the substances containing *stable* hydrogen. "A substance like oxalic acid cannot be investigated as the two hydrogens in it are labile." The method gives information only on processes in which the hydrogen (deuterium) remains fixed at the carbon atom, but not on the fate of these carbon atoms to which deuterium is not attached. There may be a few other reactions which restrict the universal application of the method and further work will be necessary to understand such limitations.

As a result of the experiments on mice fed from 2 to 10 days on a diet comprising 20 per cent., 4 per cent. and 1 per cent. deuterium-containing fats, the authors conclude that the largest part of the dietary fat, even when present in small quantities, is deposited in the fat tissues before it is utilised

The application of the method to the investigation of the intermediary products in the general cholesterol metabolism has yielded very interesting results. Thus, cholestenone is an intermediary substance in the sterol metabolism. It is probable that it is formed from the oxidation of cholesterol as a first step, and is then reduced to coprostanone.

Further applications of the method will be awaited with interest.

B. N. S.

On the Biology of the Psyllidæ (*Homoptera*).

THE work of R. U. Mathur (*Indian Forest Records*, 1935, Entomology Series, Vol. I, No. 2) on the biology of the *Psyllidæ*, furnishes important details about the habits, life-history and economic value of a family of insects that has long remained comparatively untouched by Entomologists in India generally; not only in economic (Forest) but in taxonomic entomology as well, this work supplies a long-felt want, specially for investigators in forest Psyllid fauna all over India; indeed these valuable notes will also guide economic entomologists in India, in their study of Psyllids, as affecting cultivated crops of all kinds.

B. K. M.

Immature Stages of Indian Coleoptera (*Scarabœoidea*) and Eucnomidæ.

THE studies of immature stages of Insects in general and of Coleoptera and Lepidoptera specially, cover a very large field and offer great scope. In insect classification, the custom has mostly always been to take into consideration the taxonomically valuable characters of the imaginable stages, to the utter exclusion of the several important features of the larval or immature stages. This has not only rendered classification incomplete but has made the task of Coleopterists and Lepidopterists, in specific determinations based on characters of larval instars, doubly difficult, and well-nigh impossible.

The descriptions of the immature stages of Scarabæoidea, particularly, are of vital interest to economic entomologists who have frequently to deal with the larval stages of Scarabiid, Melolonthid and Rutellid beetles; considerable damage is caused to the roots of cultivated crops of all kinds by them and an exact knowledge of their important features largely facilitates not only correct determination but effective control. Entomologists all over India welcome the valuable work of J. C. M. Gardner, (*Indian Forest Records*, 1935, Entomology Series, Vol. I, Nos. 1 and 4) on the immature stages of Coleoptera.

B. K. M.

Asexual Reproduction in Tunicates.

N. J. BERRILL in his paper on the Asexual Reproduction in the Tunicata ["Studies in Tunicate Development," *Phil. Trans. Royal Society, London*, (B), 1935, **225**, No. 526] has described the nature of budding in twenty genera of ascidians; eight of them are described for the first time, such as, Diazona, Tylobranchion, Morchellium, Euherdmania, Eudistoma, Archidistoma, Pycnoclavella and Chonorostachys. He has noted that the majority of the forms possess a regular alternation of sexual and asexual phases which coincide more or less with summer and winter, but the onset of budding seems to be dependent more on the physiological conditions of the animals than on the change of environment. The budding results in a tendency on the part of the zooid

to degenerate, the degeneration being brought about by autolysis or regression in an antero-posterior direction, which is associated with the formation of yolk-laden trophocytes. The posterior extension of migration of the trophocytes depends upon the presence or absence of the posterior-abdomen, enlarged ventral vessel and other similar factors. The medium of nutrition for the bud may be fluid where there is a physical continuity or by trophocytes in cases of physical isolation. During autolysis the tissues least specialised survive readily and the presence of at least one unspecialised cell is necessary to the development of a new individual, and buds are isolated from the parent by transverse constrictions and where a part of the old alimentary tube is present, the development is only a case of regeneration, while, where it is absent it is only reorganisation of the contained tissues. The author has contradicted the accepted view that the vascular septum of the ventral vessel has no connection whatever in embryonic development with the pericardium of the adult and hence cannot be considered as extension of the epicardium into the ventral stolon. He points out that though it is assumed that the mode of budding is primitive, there have been two major trends in specialisation, the one culminating in Distaplia, Diplosoma and probably Thaliacea where the type of budding is localised being epicardial and œsophageal, and the other through the posterior extension of zooids and buds to form Synoicids, Clavelinids and possibly ending in Perophoridæ, and the budding in the Botryllidæ and Polystylidæ is only a reacquisition of the faculty and not phyletically continuous with any other type.

Spermatogenesis of Man.

J. B. GATENBY AND H. W. BEAMS have for the first time described the behaviour of the Cytoplasmic inclusions during Spermatogenesis in man (*Quart. Journ. Micros. Sci.*, 1935, **78**, Pt. 1, No. 309). While the general behaviour of the constituents probably does not differ from that found in many other mammals, there are certain important variations which are pointed out by the authors. Three types of golgi apparatus can be distinguished; that in the sertoli cells being filamentar while it is sub-spherical in the spermatocytes and semi-dispersed in the spermatogonia. During division, the golgi apparatus breaks up into a large number of very small bodies which show a tendency of grouping round the nucleus rather than round the asters. The mitochondria are granular throughout and probably do not differ from the mitochondria in other mammals. The rôle of the centriole appears interesting. The single centriole of the spermatid soon divides into two which move close to the cell-membrane. The flagellum arises from both of them and the distal one becoming larger, assumes a ring-shape. The whole apparatus moves close to the nucleus and the proximal centriole is eventually seen to attach to the nuclear membrane. The distal ring-shaped centriole moves a certain distance down the flagellum and marks the posterior end of the middle piece. The authors describe a neck granule in addition to the two centrioles, embedded in the posterior part of the nucleus close to the proximal centriole. They do not attach any relation between this body and the centrioles and tend to think it is a derivative of the nucleus. The golgi apparatus takes very little part in the formation of the acrosome, a single bead-like body developing within the archoplasmic area becoming attached to the nuclear membrane and giving rise to the acrosome. The rest of the golgi apparatus is discarded. A post-nuclear cap is described. The sperm head has a vacuole whose function is not determined with certainty. Crystals, of either rod, batonette or pointed shape are found in a number of cell-elements of the testis and are probably no more than reserve nutriment in the cells.

The Cranial Morphology of Some Examples of Pelobatidæ (Anura).

W. K. PARKER described the gross structure of the skull of various anuran examples as early as 1881 and recently, however, the subject has received greater attention and has been studied by modern methods. In a paper in *Anat. Anz.* (Bd. 81, Nr. 4/6, S. 65–96) Mr. L. S. Ramaswami has described some aspects of the cranial morphology of the two pelobatid examples Scaphiopus and Megophrys. The cranial anatomical features of these forms are compared with those of the ancestral group "Liopelmidæ". Further, it is pointed out that Megophynæ, which according to Noble occupies a basal position, anticipates some of the characters of the next group—the pelobatinæ, of which

Scaphiopus has been studied. Moreover, Scaphiopus possesses certain exclusively individual characters. Thus the Nobelian viewpoint, that in the order of evolution, Megophrynæ occupies the lowest while Sooglossinæ the highest rungs, is questioned. The author suggests that the three sub-families Megophrynæ, Pelobatinæ and Sooglossinæ are all of equal rank and they have moved on parallel lines.

The Atomic Nucleus.

[Prof. Born first explained how he had chosen to talk about the nucleus although his main line of work was not nuclear structure: the intimate touch with the pioneers in nuclear Physics, which he had during his stay at Cambridge, was influential in his choice. Incidentally he referred the audience to his new book *The Restless Universe* with its novel illustrations which produced the same impression as a cinematographic picture when the leaves of the book were rapidly turned over. The lecturer then proceeded to give a very lively discourse on the discovery and investigation of atomic nuclei.]

THE view that an atom consists of opposite electric charges concentrated at a great distance from each other and not uniformly distributed throughout the atom was put forward by Lenard in his theory of dynamides, long before Rutherford proposed the nuclear theory of the atom. The idea behind the attempts to unravel the mystery of the nucleus was to pierce it by swift particles and thus gain a knowledge of its contents just as a closed mechanism has to be taken to pieces in order to lay bare its inner details. The discovery of Radioactivity had placed such swift projectiles in the hands of the physicist. The radioactive elements like Uranium, Polonium and Radium emit three different kinds of radiation which were named α-, β- and γ-rays. The α-rays consist of helium atoms which have lost two electrons, the β-particles are swift electrons and the γ-rays are waves like X-rays but of higher frequency. It was natural that Rutherford who had done important work in Radioactivity should study the effect of bombarding different substances by means of α-particles. It was also natural that one of the best means of studying the tracks of these particles, *viz.*, the Wilson cloud chamber should have been invented in England which is famous for its fog. When a sudden expansion is caused to take place in a chamber saturated with water vapour, the fall of temperature produces supersaturation and the vapour will condense into drops wherever some dust or charged particles are present. Since the α-particles are heavy projectiles with high energy their path is thickly studded with charged ions and droplets forming on these show the track of the α-particle as a thick straight line. Just as the projectiles from a heavy gun spread swift destruction thickly along their path while the bullets from pistols produce here and there a chance casuality and are also more easily turned from their course, the β-particles in contrast to the α-rays, produce zig-zag tracks sparsely covered with droplets. The γ-rays, on the other hand, first produce electrons along their path and the tracks of the latter then show up the passage of the γ-rays.

The experiments of Rutherford on the scattering of α-particles showed that these particles were generally deflected by small amounts, but now and then there occurs a very large deviation. Rutherford saw that such a deviation was like the passage of a comet round the sun and applying a similar calculation he was able to deduce the distance to which the α-particle had approached the positively charged part of the atom in order to suffer such large deflections as were observed, and found the distances to be sub-atomic.

The periodic system of the elements assigns to each element a number denoting its place in the table called the atomic number. This was now identified by Mosely to be identical with the positive charge on the nucleus. The simplest nucleus is that of hydrogen having unit charge and is called the proton. The other charges are multiples of these but the chemical atomic weights of the various atoms are not exact multiples of the weight of a proton. The explanation was furnished by the work of J. J. Thomson on positive-ray parabolas and the refinement which Aston introduced by designing his mass-spectrograph. This work showed that the masses of the different atoms were really integral multiples of that of the proton, thus reviving Prout's hypothesis. The chemical atomic weights were shown to be different from integers because the chemical elements are mixtures of atoms of different mass but with the same charge. Such atoms occupy the same place in the periodic table and are called isotopes. The separation of isotopes is very difficult; but in the case of the most interesting isotope, *viz.*, the heavy isotope of hydrogen discovered by Urey (for which he obtained the Nobel Prize) has been separated, with the help of its most important compound: heavy water. G. Hertz has also succeeded in separating the isotopes of neon and of hydrogen by repeated diffusion through a large number of porcelain vessels connected to diffusion pumps. Prof. Born had seen his apparatus filling a large room and witnessed its working.

Starting from the nuclear model of the atom, Bohr assumed that the electron, *e.g.*, in the hydrogen atom was revolving round the nucleus but it could do so only at definite distances from the centre so that its angular momentum changed from one position to another by integral multiples of h—Planck's constant—and that the difference in the energy when an electron jumped from one orbit to another was radiated as a single quantum $h\nu$ of frequency ν. Bohr was thus able to explain Balmer's formula for the lines of hydrogen and to deduce the constant occurring in it with great accuracy. He elaborated his theory further by the correspondence consideration that in the limit, classical theory and quantum theory should lead

to the same result but there were a number of difficulties which were only removed by the Quantum Mechanics of Heisenberg and Schrödinger. According to this we no longer think of the electron as actually describing an orbit, but the orbits of the earlier theory with some modifications are the loci of the most probable positions of the electron. The quantum mechanics was also very successful in explaining how radioactive atoms send out quite by chance a particle now and then, though nobody can predict whether a particular atom is going to explode now or a hundred years hence. The explanation was offered by Gamow and by Gurney and Condon. The constituents of the nucleus have to overcome a large resistance due to their mutual attraction if they are to come out. According to classical ideas, they can never come out if their energy is less than that required to overcome this opposition while actually those that come out are shown by experiment to have an energy less than this. Taking the analogy of bodies within a crater wall, we see that they can fall outside the crater only if originally they were at a greater height. But if they were waves a certain fraction of the waves would pass through the wall as sound waves do, and if we assume the wall to become thinner at the top, waves passing near the top would penetrate easier. In a similar way the quantum mechanics associates the particles inside the nucleus with waves which have thinner barrier to pass through the larger of the energy particles and thus the fraction of these particles which comes out is the larger, the greater their energy. This is the explanation of the Geiger-Nuttall law in Radioactivity.

Further progress in our knowledge of the nucleus came from the work of Rutherford who bombarded Nitrogen with α-particles and showed that hydrogen was given out. Recent improvements in technique have enabled Cockroft and Walton and Lawrence to produce artificial missiles which disrupt a number of nuclei. Here again theoretical calculations by Gamow according to quantum mechanics showed first the possibility of breaking up the nucleus even with missiles having lower energy than the binding energy of the constituents of the nucleus, if the missile itself is caught by the nucleus.

The discovery of neutrons *i.e.*, uncharged particles of the same mass as the hydrogen nucleus (proton) by Curie and Joliot and Chadwick cleared up a number of difficulties associated with the previous assumption that nuclei consist of protons and electrons. These neutrons do not produce tracks in a cloud chamber and they cannot be stopped by large thicknesses of such heavy metals as lead. But peculiarly enough they are absorbed by light substances rich in protons such as paraffin, and the protons which they dislodge can then be studied by means of their tracks and yield information about the neutrons. Heisenberg has developed a general theory of nuclei assuming them to contain only protons and neutrons and assuming a general expression for their interaction. Further advance is to be sought in a satisfactory theory of β-decay. In course of trying to explain the fact that in β-decay electrons of all energies are sent out and not merely discontinuous groups, Pauli suggested that along with the electrons uncharged particles of very small mass called neutrinos are emitted along with the electrons, and Fermi has developed this theory to a large extent. Interesting experiments have been made at Cambridge to detect these neutrinos. They may possibly be capable of penetrating miles of lead.

Another discovery foreshadowed by theory is that of the positron. Dirac had propounded a theory of the electron which showed that positive particles of similar mass should exist. Examining the "showers" of particles produced by Cosmic radiations, by means of a Wilson chamber placed in a magnetic field, Anderson detected electron tracks curved in opposite ways. By placing a sheet of lead across the chamber and finding on which side the energy decreased resulting in greater curvature of the path, he was able to demonstrate that the particles producing both classes of tracks were moving in the same direction and therefore opposite curvature indicated opposite charge. This proved the existence of positrons and also showed that a γ-ray produces an electron-positron pair. Thus matter has been created out of radiation as definitely proved later by Curie and Joliot. The reverse of this, namely, the annihilation of an electron-positron pair resulting in high frequency γ-radiation has also been observed.

Lastly must be mentioned the discovery of artificial radioactivity by Curie and Joliot, for which they have recently obtained the Nobel Prize. These observations give fresh information about the stability of the nuclei. But just at the present moment the definite structure of the nucleus is not yet known and much further progress will have to be made before the question is finally settled. We must find an explanation, for example, for the spins of nuclei, the spin being an important property in itself, but of special interest to the audience owing to the fact that Prof. Venkatesachar and his collaborators were engaged in its investigation. Further the magnetic moments of nuclei have to be interpreted in terms of the moments of the neutron and the proton; the latter has been experimentally found by Stern to be 2.5/1840 Bohr Magnetons. However, said Prof. Born, this progress may be achieved in a short time, and with this expression of hope, he concluded his most interesting address which had kept a mixed audience of students and scientists spell-bound throughout the hour elapsed during its delivery.

T. S. S.

Properties, Characteristics and Uses of Stainless Steel.*

THE investigations on this important development of metallurgy during the last 25 years, and particularly after the war, have resulted in many brands of stainless steel, called by several names. It is, therefore, not surprising that Mr. Main should have found it difficult to give a single definition for stainless steels. The two varieties of this class of steel dealt with by the lecturer are really typical of this class. Now that there are several makes of almost the same kind of product, having practically the same chemical composition, it would perhaps be misleading to classify all of them under the same category. It would be better to name them by the chief characteristics which they possess such as acid-resisting, rust-free, heat-resisting, etc.

The chief characteristics of plain chromium steels largely used in the manufacture of cutlery have been dealt with in detail and attention is drawn to the prevailing belief that ordinary carbon steel gives greater hardness to the cutlery and retains it better than the stainless type. If stainless steel cutlery has to maintain the same reputation as plain carbon steel product and still be competitive with it, it would serve no practical purpose to improve hardness by adding other valuable elements and thus adding to the cost. It is a point for investigation if carbon itself could not be increased beyond the present limit of 0.35 per cent. keeping the chromium content round about 14 per cent. It is of course practically impossible to handle a product like the above with our present methods of heat treatment and new methods of working will have to be developed. This would incidentally help a larger use of the cheaper grades of high-carbon ferro-chrome.

There is no doubt that for decorative and household use the famous "18–8" variety is best suited. Here again the presence of a large quantity of nickel is making the product very expensive. The question whether an improved technique for the manufacture of stainless irons could be developed so that a cheaper substitute may be made available for the chrome-nickel type of stainless steel, deserves investigation.

Considerable work is at present being done in important Institutes of research with a view to determine the relative merits of different metals and alloys for containing foodstuffs. The author's statement that there is not the slightest fear of food contamination and consequent poisoning, in stainless steel vessels and that there is no anxiety on this score is very assuring.

The use of stainless steels in the chemical industries is perhaps much more extensive than in other fields. Almost all the important industries use this material in greater or smaller degree, and it is believed that the high initial cost paid for the stainless steel equipment is more than compensated by the saving due to absence of frequent repairs and renewals. It is hoped that in course of time some modified form of chrome-nickel stainless steel will be evolved which would resist the action of the two important acids, *viz.*, sulphuric and hydrochloric, which easily attack the present brands of stainless steel.

In the field of mechanical engineering the use of plain chromium steels is becoming more and more common. Most of the high pressure steam turbines have blades made of a special type of chromium-nickel steel. Pump impellers and parts of automobiles and aeroplanes are made of stainless steel. The stainless steel train referred to by the author is of special interest since the deterioration on ordinary steel trains due to corrosion is stated to be on the increase. Apart from the decrease in weight of the carriages, the absence of annual cleaning and painting and complete renewal perhaps once in about 12–15 years should make it worth while to take up a thorough investigation of the overall relative merits of the two types of rolling stock at least for fast express trains.

A reference is made to a series of new cheap alloy steels which resist corrosion better than the plain carbon steels, chiefly copper and copper chromium steels. But it is doubtful if any reasonably cheap steel could be produced which would be rust-free and at the same time capable of being rolled into the numerous sections used in structural Engineering.

A brief reference has been made to the manufacture of stainless steels, and the several manipulative processes required for finishing them. A passing mention may be made here of the new direct processes for manufacturing stainless steel. It is true that several of the present patents cannot be strictly called commercially successful, but one or two processes especially Wild's process, seems full of promise. The mechanical working of steel after the ingot stage has been receiving considerable attention and any improvement in the mechanical equipment handling this type of steel with a view to minimise rejections should be welcome. After all the demand for this type of special product is largely guided by the price at which it can be sold, and attempts must therefore be made in the direction of cheapening the cost of production during the several stages of manufacture.

The theory of protective film produced naturally on the steel, advanced by the author, is full of interest. The popular impression of stainless steels was that the stainless character is in the substance itself rather than due to any protective coating on the outside. The claim put forward by the manufacturers of stainless steel products that these products are superior to those having special coatings of chromium or nickel was largely based on this belief.

The several practical details given by the author in relation to cutlery steel, temper colours and the non-magnetic character of nickel steel, and the precautions that should be observed in working them should be very useful to the user of this class of steels. Reference to the recently discovered defect of intergranular corrosion when fabricating stainless steels and the special methods of overcoming it is also of practical value.

The future of stainless steel depends largely on the extent to which it can compete with its likely rivals in chemical industries and household utensils, these rivals being brass, bronze and

* "Properties, Characteristics and Uses of Stainless Steel," Lecture by S. A. Main, B.Sc., F.I.P., Royal Society of Arts, 1935, **83**, 672.

aluminium. The next step in the development of this class of steels should therefore be mainly in the direction of cheapening the cost of production. One method is to perfect the several practical details connected with the direct processes referred to above. These processes will involve the use of lower grades of chrome ore, thus conserving the richer chromium resources of the world for only highly specialised products. Just as the iron ores containing round about 30-35 per cent. of iron were considered 50 years ago as being quite uneconomical for conversion into iron, while now the same class of ore is largely used in blast furnaces in England and on the Continent, similarly the development of suitable methods for economical utilisation of large deposits of low grade chrome ores should prove of considerable help.

D. V. KRISHNA RAO.

Science Notes.

A Note on the Sapogenin from Soapnuts.—Dr. S. V. Shah, Rajaram College, Kolhapur, writes under date 16th November, 1935: "On referring to literature one finds that work on this sapogenin was begun by Winterstein and co-workers (Hoppe-Seyler's *Zeit. Physiol. Chem.*, 1911, **75**, 427; *Helv. Chim. Acta*, 1919, **2**, 198). But more recently W. A. Jacobs took up the same work (*J. Biol. Chem.*, 1925, **63**, 621; **64**, 379).

"According to Winterstein the sapogenin is a neutral optically inactive product having the molecular formula $C_{18}H_{28}O_{3}$, molecular weight 280, and melting point 319-320°. Jacobs described it to be dextro-rotatory [$(\alpha)_D$, 81°; l=1.009 in pyridine] and acidic in nature as it yields a sodium salt, and to have the molecular formula $C_{31}H_{50}O_4$. He thus found it to be exactly identical with hederagenin of Van der Haar (*Ber.*, 1921, **54**, 3142). For a moment one could argue that Winterstein's product was impure and as suspected by him was a mixture and the reduced optical activity was not observed in dilute solution.

"Further on treatment with concentrated nitric acid, Winterstein obtained from the sapogenin 1:5-dinitro- and 1:8-dinitro-naphthalenes. This appears more in support of Winterstein's than Jacobs' formula, as the removal of 21 carbon atoms from the molecule by nitric acid is rather unexpected. Windaus and Shah, Windaus and Linsert (*Zeit. Physiol. Chem.*, 1926, **151**, 86; 1925, **147**, 275) could not remove by this method more than five carbon atoms from oxydigitogenic, digitogenic and gitogenic acids. On the other hand, a degradation by eight carbon atoms (from 18 to 10) accepting Winterstein's formula appears more probable also according to recent work. Tschesche (*Ber.*, 1935, **1393**, 1412) has shown that the skeletons of digitogenin gitogenin and tigogenin have a side chain of eight carbon atoms in addition to four hydrogenated rings. In the case of these genins it is this side-chain which is attacked by nitric acid with the removal of five carbon atoms. By analogy, it is more probable, that, in the case of the soapnut sapogenin, eight carbon atoms would be removed by nitric acid instead of twenty-one carbon atoms thus supporting more the Winterstein's than Jacobs' formula for the sapogenin."

An Iron Horse from the Central Provinces.—Among the exhibits that were shown and commented upon at the ordinary monthly meeting of the Asiatic Society of Bengal, held on Monday, the 2nd December, was an iron horse. This exhibit which was shown by Sir Lewis Fermor "was obtained some 32 years ago from the top of a hill of manganese-ore in the Chhindwara district. The manganese-ore cropped out in large black masses, which in one place had been daubed with red paint and treated as a village god. Lying about were a number of clay horses and an iron one. This hill has since been worked as a manganese mine, and is now represented by a large hole in the ground.

The interest of this specimen is perhaps threefold. In the first place it has been exposed to the moist air of Calcutta for over 31 years, without any appearance of rust, from which one can deduce that it is made of very pure iron, as in the case of the iron pillar at Delhi. Its age, of course, is unknown.

The second point of interest is that it must be regarded as an example of primitive art. It is made mainly from three pieces of iron—one piece forming the head, the body and the tail, another piece the front pair of legs, and a third piece the hind pair. The way in which the pairs of legs are bent over the body provides a representation of a saddle. In addition, there are two extra small pieces of iron welded on to form the ears. Two touches of vermilion on the head suggest the eyes. The horse is so constructed as to be unstable when standing on its four feet, but to be stable standing on a tripod consisting of its hind legs and tail. It is a little over 7 inches long, and is in consequence less than one hand high.

I have shown this horse on occasion to many people, and no one appears to have seen a similar horse before, but—and this is the third point of interest—it has been suggested to me that it should be compared with the horses that are offered to the Southern Indian village deity known as *Iyenar*—a beneficent male deity, who is regarded as the village watchman and whose duty is to patrol the village and fields at night. If this suggestion is correct, it is an indication of the extension of this South Indian deity as far north as the Chhindwara district in the Central Provinces. An account of *Iyenar* is given in Bishop Whitehead's "Village Gods of Southern India". These village gods, according to Bishop Whitehead, date from before the Aryan invasion and must be regarded as Dravidian deities. The Gonds of the Central Provinces are, of course, Dravidians, and it is not, therefore, surprising that worship of this deity *Iyenar* may have extended to the Central Provinces. I was not, however, given any name for the deity, and have no knowledge whether there is any local name for *Iyenar* in the Central Provinces."

The Food of 'Peking Man'.—An answer to the interesting question "what constituted the food of the earliest man-like animals?" has been provided by the painstaking excavations of the bone-bearing masses of breccia conducted by the members of the National Geological Survey of China. The living quarters of the Peking man, *Sinanthropus pekingensis*, dating back to the beginning of Pleistacene or Ice Age, have been recently unearthed, in which are found, in addition to the skulls and human teeth of the oldest inhabitants, stone implements, hearths and uneaten fragments of food. These afford evidence regarding the dietary habits of the early man (*cf.*, "The food of Peking man," *News Service Bulletin, Carnegie Institute of Washington*, 1935, 3, No. 25). Crudely fashioned flakes of quartz served to cut and scrape. Several feet of ashes piled against the walls of the cave show that the early man knew the use of fire. In the ashes have been discovered bits of incompletely burnt wood and abundant fragments of charred bones. The Peking man must have used game animals for his food. Thousands of fragments of shells of hackberry seeds occurring in the breccia, constitute the earliest record of the use of plant food by the prehistoric man. These berries were perhaps used to flavour the meat, as is being done by the natives of the South-West of Armenia to this day. We have thus a good record of the feeding habits of the Peking man preserved through the obscurity of over a million years.

* * *

Timber Research. (His Majesty's Stationery Office, Price 1*s*. 6*d*.).—The Report of the Forest Products Research Board for the Year 1934 gives an account of the progress made during the year in the investigation of the many and varied problems concerned with the efficient utilisation of timber. The work covers a wide field and involves the study of the physical, mechanical and seasoning properties and the working qualities of timbers, and the control of fungal and insect pests. The Report cannot fail to interest those concerned with the handling and use of timber, research into which means large economies to the timber-using industries and professions.

* * *

Indian Central Cotton Committee, November 1935.—(1) DEVELOPMENT OF COTTON CULTIVATION IN SIND:—*Botanical Work*.—Replicated field-scale trials of the improved Sind American types 289 F–1, now known as 'Sind Sudhar' cotton, 285 F–2 and 4F–98, together with the improved *deshi* type 27 W.N. were conducted both at Sakrand and at the Government Seed Farm, Mirpurkhas. Progress was made in the selection work with Punjab-American cottons and more extensive trials with a new and promising strain namely 289 F–20 were conducted at Mirpurkhas. African cotton types A 12 and U 4, were obtained and similarly tested. Bulk samples of imported Uganda, Morad (Egyptian) and Sudan cottons are also being studied by the staff of the Botanical Section and put to further tests. *Physiological Investigations*.—The study of factors responsible for 'red leaf' blight on American and Egyptian cottons grown in Sind with the object of obtaining information regarding the possibility of control of this disease, or the breeding of resistant types has been continued. The Indian Central Cotton Committee in conjunction with the Imperial Council of Agricultural Research, made a grant of Rs. 16,030 in January 1933, for a period of three and a half years for an enquiry into the cost of production of cotton and sugarcane with their rotating crops in Sind. *Sind Cotton Extension Scheme*.—The activities covered by this scheme. financed by the Indian Central Cotton Committee are being pursued in two Sections, one in the Left Bank areas and the other in the Right Bank areas of the River Indus. In the Left Bank Section, tests carried on with regard to the respective yields and suitability for extension of different varieties of cotton, in Thar Parkar, Nawabshah and Hyderabad Districts have demonstrated the high yielding capacity of 289 F–1, 4 F–98 and (*Deshi*) 27 W. N. Plots for the cultivation of these varieties were laid down at three centres and the best methods of growing them were shown to the cultivators. In the Right Bank Section—hitherto a non-cotton growing area—the work on thirty-five demonstration plots in the Dadu, Larkhana and Sukkar Districts, brought promising results from the growing of 4 F–98, 1500 acres were cultivated under cotton in *Kharif* season of 1933 and there was every indication of a further extension of cotton cultivation in this area. Seed of improved varieties of cotton sufficient for the cultivation of 4,000 acres was distributed and intensive propaganda was conducted in the districts to induce Zamindars to take up cotton cultivation.

During the year 1935–36 the cotton area on the Right Bank is over 16,000 acres which is about four times of what it was in the previous year.

The interesting point during the year has been that the area has been mostly under the American variety and the *deshi* has been eliminated from the tract.

(2) FIBRE-MATURITY IN RELATION TO FIBRE AND YARN CHARACTERISTICS OF INDIAN COTTONS: The exact relationships between the maturity count of cotton and its fibre properties on the one hand and the number of knotted and tangled fibres, technically known as 'neps' in the yarn, on the other, have been investigated by Dr. Nazir Ahmad and Mr. Amar Nath Gulati. The results showed that the variety known as *C.A*. 9 tops the list, having over 80 per cent. of fibres fully mature, while in *Goghari E*. 2, which comes at the bottom of the list, only 14 per cent. of mature fibres were observed. It was also found that cottons like *Mollisoni* produced practically 'nep' free yarns while type 413 contained as many as 19 'neps' per yard and could only be described as exceedingly neppy. The investigators then proceeded to study the influence of such factors as season, locality of growth, heredity, etc., on the degree of fibre maturity of a cotton and the relationship of the latter with fibre properties and yarn characteristics.

As a result of these investigations it is concluded that (*a*) Mature fibres are on the whole stronger than either half-mature or immature fibres. (*b*) Percentage of immature hairs in a cotton has an important bearing on the formation of 'neps' in yarns and cotton comprising a high percentage of immature hairs are likely to give rise to yarns containing proportionately large number of 'neps'. (*c*) There is no

significant relation between maturity and staple length, but detailed analysis showed that a majority of short stapled cotton possessed high percentages of mature fibres while a majority of comparatively long stapled cottons are characterised by low percentages of mature hairs. (*d*) On a detailed analysis it was found that in medium and long stapled cottons higher fibre-maturity was usually associated with better spinning performance, while in short stapled cottons the reverse was the case.

These results are embodied in Bulletin No. 20, issued by the Technological Laboratory of the Indian Central Cotton Committee (Price as. 8). The Bulletin describes the technical details of the tests employed in the investigation and is illustrated with charts and interesting photomicrographs.

* * *

Oxidation and Scaling of Heated Solid Metals. (His Majesty's Stationery Office. Price 2*s*. 6*d*. net).—This volume issued by the Department of Scientific and Industrial Research contains a full critical review by acknowledged experts of the recent work on oxidation and scaling of heated solid metals summarising existing information and drawing attention to problems requiring further research. It is mainly concerned with the mechanism and rate of oxidation and properties of oxide layers, but it also contains sections describing the practical effects of oxidation and scaling and the methods of prevention to be employed.

* * *

New Applications for Superphosphate.—The Research Institute for Fertilisers and Insectifungicides has recently established that double superphosphate from apatite and thermic phosphoric acid with a total content of 50·17 per cent. of phosphoric acid gives positive results when used for the dry treatment of millet and wheat seed against smut. Six grams of superphosphate per kg. of seed proved sufficient. Field experiments have shown that millet and wheat seeds treated in this way did not suffer from smut, whereas on the check plots sown from untreated seeds the smut infestation was as much as 30 per cent. The germination rate of wheat was somewhat reduced, whereas millet retained its germination rate.—(*Industrial and Eng. Chem.*, 1935, **13**, 406.)

* * *

Harrison's Chronometers at the Science Museum.—The Science Museum, South Kensington, has recently acquired on loan, by courtesy of the Admiralty, all four of the pioneer marine time-keepers made by John Harrison between 1729 and 1759. With these instruments Harrison was the first to show that it was possible to construct a portable time-keeper which would keep sufficiently accurate time at sea to be of use in determining a vessel's longitude, and thus solved the problem of "finding the longitude", which had baffled men of science and inventors for over 200 years. Harrison's instruments were the first balance-wheel time-keepers to embody any kind of compensation for the effects of change of temperature. In all his four instruments compensation is provided by varying the effective length of the balance-spring, the mechanical details varying in the different individuals. The first three time-keepers are large clocks each weighing over 50 lbs., but the fourth is much smaller, being in the form of a large watch a little above 5 ins. in diameter. The third and fourth instruments, in particular, are of great complexity and were obsolete even in Harrison's life-time, for after he had shown the possibility of constructing an accurate marine time-keeper other makers were able to devise simpler means of achieving the same ends. All four of Harrison's instruments have been cleaned, repaired and put into working order by Lt.-Commander R. T. Gould, and they are now on exhibition in the Museum in working condition.—(*J. of Sci. Instruments*, 1935, **12**, 339.)

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Radio Feeler.—A radio device reputed to enable a ship to "feel" its way through fog hasbeen tested on the French "*Normande*". A radio beam of a wave-length of 16 centimetres describes an arc of 45 degrees in the direction of the ship's travel and if the beam is intercepted by any obstacle in its path, a loud speaker announces the fact to officers on the bridge. It is stated that objects have been detected at distances up to four miles.—(*Wireless World*, 1935, **37**, 491.)

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Plasticised Sulphur in Road Construction.—Experiments at the Mellon Institute indicate that plasticised sulphur which may be made by reacting sulphur with organic sulphides, polysulphides or polymers of these, can be used successfully as a binder for brick in road construction. Test panels subjected to heat showed no signs of the material exuding at temperatures well above the range met in pavements. A test road will be constructed by the State of Ohio next Spring. Plasticised sulphur gives a very fluid material at the temperature of application which is about 300° F.—(*Canadian Chemist and Metallurgist*, 1935, **19**, 279-35.)

* * *

A New Organic Reagent.—Rhenium, which was recently discovered, is being manufactured in Germany on a commercial basis, as it appears to have some industrial uses. Many attempts have been made to evolve a method for the analysis of the metal, but so far without success. It is now reported (*Chemical Age*, 1935, **33**, 441) that a new radical, tetraphenylarsonium, prepared from triphenyl arsine has been discovered by Bucke and Monroe, which can be successfully employed in the determination of Rhenium. Tetraphenylarsonium-per-rhenate is a crystalline and extremely insoluble precipitate with a high molecular weight and hence is well suited to the precipitation of this metal and its separation from other metals.

A very sensitive volumetric method for the estimation of iodine as well as the arsonium base itself, can be worked up by utilising tetraphenylarsonium chloride which forms an extremely insoluble periodate. As this chloride forms insoluble compounds with chlorides of cadmium, zinc, antimony, tin, mercury, quadrivalent lead, bismuth, platinum, gold, it can be successfully employed for the quantitative analysis of these metals. Very rapid estimations of zinc, cadmium, mercury, platinum and gold have been made by making use of this fact, with a high degree of accuracy.

American Stratosphere Balloon, Explorer II.—A notable achievement falls to the credit of Captain A. W. Stevens and Earl A. Anderson of the U.S. Army Air Corps, who, according to the reports in the daily press, have successfully piloted their stratosphere balloon up to the record height of 74,000 feet. The previous record was held by the ill-fated Russian balloon *Osoaviakhim* which probably reached a height of 72,000 feet on January 30, 1934. After the first set-back of last July, when the top of *Explorer* II burst and released 375,000 cubic feet of helium, another occurred on Monday, November 11, when a 20 feet rent in the envelope produced during its inflation, had to be repaired at the last moment. The ascent was made at 7 a.m. from a point eleven miles west of Rapid City, and a safe landing was made in the evening at White Lake, South Dakota. Capt. Stevens reported by wireless that at his maximum height the external temperature was — 55°C., the cosmic ray intensity 150 times at earth's surface and that the sky had become a jet black awning.—(*Nature*, 1935, **136**, 786.)

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Animal Experiments in the Investigation of Diseases.—The achievements of Louis Pasteur and Robert Koch have established the importance of animal experiments in the study of the cause and cure of diseases. In a valuable article published in *Research and Progress* (1935, 1, 188) Professor Paul Uhlenhuth of the University of Freiburg, has furnished a brief account of the more recent researches on the nature of the diseases and the biology of the germs causing them. Weils disease, or infectious jaundice which was so prevalent during the Great War, is caused by *Spirochæta icterohæmorrhagiæ*; the experiments leading to this discovery were carried out on guinea-pigs. The deficiency diseases are all studied through animal experiments. Not only are animals used for discovering the causal agencies but also as means of diagnosing difficult cases of infectious diseases; mouse is used in the diagnosis of anthrax and tetanus and guinea-pig for the diagnosis of glanders and particularly of tuberculosis. Experiments with rats and guinea-pigs are officially prescribed for diagnosing small-pox and rabies. Another way in which animals have proved valuable in diagnosing diseases is in the agglutinin and bacteriolytic reactions. The precipitin test offers an extremely sensitive and valuable test in the identification of specific proteins and finds several applications, as for instance in the detection of adulteration of foods. The same reaction has served to establish the blood relation of the horse and the donkey, of the dog and the fox and of the man and the ape. The remedial and protective sera used in combating diseases are obtained from animals; the examples of such are found in antidiphtheritic and antitetanus sera. Animals also give the important vaccines—those against small-pox, rabies, etc. Experiments with animals form the basis of chemo-therapy and have assisted in the discovery of arsenical preparations for syphilis, antimony preparations for kalaazar etc. Chemotherapeutic research through experiments with animals has ultimate possibilities of discovering remedies for the so-called incurable diseases such as, cancer, and bacterial infections (*sepsis, typhus*, etc.)

World Petroleum Congress.—The Association Francaise des Techniciens du Petrolu have issued an invitation to hold the World Petroleum Congress, 2nd Session, in Paris. in June or July 1937. The Council of the Institution of Petroleum Technologists have accepted the invitation. The task of organising will devolve on the French Association but the Council of the Institute of Petroleum Technologists will remain in close touch with the arrangements.

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Third World Power Conference.—It is announced that the Third World Power Conference will be held in Washington, U. S. A., from September 7 to 12, 1936. The general subject to be discussed at the Conference is the National Power Economy. The 2nd Congress of the International Commission on Large Dams of the World Power Conference will be held in Washington at the same time.

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12th Conference of International Union of Chemistry.—The Executive Committee have changed the opening date of the Conference to Sunday, August 16, 1936, and will close on Saturday, August 22. The conference will be held in Luzern. An excursion to Zurich will be arranged on August 19. All communications are to be addressed to Fr. Fichter, Laboratorium des Kantons-Chemikers, Vonmattltrase, 16, Luzern, Switzerland.

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The All-India Medical Research Workers' Conference was held at Calcutta during the first week of this month. Major-General Sir Francis Connor, Officiating Director-General of Medical Services, opened the Conference.

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The Fourth All-India Industrial Exhibition will be held in Delhi, from February 29th, 1936.

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Broadcasting in India.—A Radio Exhibition was held in Bombay on 9th December. Mr. Lionel Fieldon, Controllor of Broadcasting in India, opened the Exhibition. In the course of his speech, Mr. Fieldon said that the Government hoped to call a Conference of Representatives of States and Provinces, to discuss the future development of broadcasting. Dealing with the future, he said that "broadcasting was the gift of science to the people which, if used, with intelligence and impartiality, would infuse in the people, the spirit of good-will and mutual understanding and be a bridge to the millennium."

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The John Fritz Gold Medal for 1936 has been awarded to Prof. William Frederick Durand of the Stanford University. Prof. Durand is an authority in hydro-dynamic and æro-dynamic science and in its practical application, he is an outstanding leader in research and in Engineering Education. It may be mentioned that this medal will be awarded each year for 'notable scientific or industrial achievement'.

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Mr. T. H. Ritchie, M.A., B.Sc., Director of Agriculture, Central Provinces, has been appointed Director of Agriculture, U. P. Mr. T. C. McDougall, M.A., B.Sc., I.A.S., succeeded Mr. Ritchie as Director of Agriculture, C.P.

We are glad to announce that Dr. Subrahmanyan Chandrasekhar, Fellow of the Trinity College, Cambridge, has been appointed Lecturer in Cosmic Physics at Harvard University.

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Lieut.-Col. R. N. Chopra, I.M.S., has been appointed Honorary Physician to His Majesty the King, in succession to Major-General Sir Robert McCarrison, retired. Lieut.-Col. Chopra has been promoted to the rank of Brevet Colonel.

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The honorary degree of Ph.D., has been conferred on Dewan Bahadur L. K. Ananthakrishna Iyer by the Breslau University.

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The Degree of Doctor of Science (D.Sc.) has been conferred on Dr. S. V. Desai, by the Senate of the London University.

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Doctor Sir Upendra Nath Brahmachari has been re-appointed by the Senate of the Calcutta University to the Court of the Indian Institute of Science, Bangalore, for the period 1936–40.

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The Imperial Bureau of Soil Science, has recently issued a complete "Bibliography of Soil Science, Fertilizers and General Agronomy" covering the whole scientific literature of the world on soil and allied sciences during 1931–34. This extremely comprehensive Bibliography gives the reference to practically every paper published during that period on the different branches of soil science, both pure and applied, on the use of fertilisers, on the cultivation of all the chief economic crops (over 140, including forests, are listed in the index) and on plant diseases in relation to soils. The references are arranged by subjects according to the Universal Decimal Classification, which is adequately explained in the Preface. The volume also contains an index to the Decimal Classification, an alphabetical cross-index to every subject on which the papers listed have been written, an author index containing over 4,000 names, and a list of the abbreviations used, and the full titles and places of issue (where known) of 800 journals, etc., from which the references in the Bibliography have been taken.

The Bibliography has been compiled from the references which appeared in the first 41 issues of the Bureau's monthly lists of *Publications Relating to Soils and Fertilisers*. An unusual feature is that the literature of almost every country has been covered equally well, thanks to the exceptional facilities for procuring foreign periodicals which the Soil Bureau enjoys. Considering its scope and the amount of information it contains, the book has been made remarkably compact, without detriment to its readability. It should be a most valuable reference book to every agricultural scientist whose work is, in any way, connected with the soil. The Bureau intends to issue further similar bibliographies at intervals of 3–4 years, and in this way gradually to build up a complete reference library to the whole literature of the soil over an extended period of time.

Crown Octavo, pp. 504. Bound in cloth, with gold lettering, price 25/- net; post free, from the Imperial Bureau of Soil Science, Harpenden, England.

Announcements.

The Society for the Study and Promotion of Family Hygiene.—A new organisation whose aim is, broadly, to help in increasing happiness in the marital and family relationships and ensuring a general improvement of the human races, has recently been started at Bombay. The Society aims to provide facilities for research and proposes to (1) grant scholarships and endowments for stimulating and organising research, (2) publish reports, leaflets, dealing with topics connected with family, marriage and allied subjects in their social and biological aspects, (3) organise propaganda for the introduction of sex education in schools and other teaching institutions, (4) start consultation centres and contraceptive clinics for promoting family and marriage hygiene, (5) hold periodical conferences and arrange lectures, (6) make available to members, a library containing selected scientific books, (7) collect and collate manuscripts, press cuttings, etc., (8) build up a museum for education purposes, etc., etc. The promoters expect that the Society would either expand into an international organisation in due course, or would be affiliated with similar organisations in other parts of the world.

An all-India Council and the different Provincial Councils are under formation. The membership is open to adults of both sexes who are in sympathy with the objects of the Society. The annual subscription will be Rs. 10 for members and Rs. 15 for Fellows. Further information regarding the Society can be obtained from the General Secretary, Society for the Study and Promotion of Family Hygiene, Kodak House, Hornby Road, Fort, Bombay.

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The First All-India Obstetric and Gynæcological Congress, 1936.—Under the joint auspices of the Bombay Obstetric and Gynæcological Society and the Obstetric and Gynæcological Society of Southern India, the first All-India Obstetric and Gynæcological Congress will be held at Madras on the 2nd, 3rd and 4th January, 1936. Subjects to be considered will be discussed under three sections, *viz.*, Obstetric section, Gynæcological section and Maternity and Child-Welfare section. A scientific exhibition of scientific appliances, foodstuffs, drugs and scientific books, will be held during the session. All communications should be addressed to the President of the Obstetric and Gynæcological Society of Southern India, Government Hospital for Women and Children, Egmore, Madras.

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First Indian Population Conference.—The Conference will be held on January 27–28, in Lucknow, with Sir U. N. Brahmachari as General President. Prof. Radha Kamal Mukherjee, is the convener of the Conference. Discussions on problems of social biology and hygiene, vital statistics, production and population trends in various Provinces, etc., will be held during the Conference.

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We acknowledge with thanks the receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVI, Pt. 11.

"The Allahabad Farmer," Vol. IX, No. 6, Nov. 1935.

"Journal of Agricultural Research," Vol. 51, No. 3, and Index to Vol. 50.

"The Journal of the Royal Society of Arts," Vol. LXXXIII, Nos. 4327–4330.

"Biochemical Journal," Vol. 29, No. 10, October, 1935.

"American Journal of Botany," Vol. 22, No. 9, November 1935.

"The Journal of Institute of Brewing," Vol. XLI (Vol. XXXII—New Series), No. 11.

"Chemical Age," Vol. 33, Nos. 852–855.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 11.

"The Journal of Indian Chemical Society," Vol. 12, No. 10, October 1935.

"The Cambridge Bulletin," Vol. LXXVII, November 1935.

"Experimental Station Record," Vol. 73, No. 5, November 1935.

"Journal of Entomology and Zoology", Vol. 27, Nos. 2–3.

"Forschungen and Fortschritte," Jahrgang 11, Nos. 31–33.

"Indian Forest Records," Vol. I, No. 5,—Entomology. Neue Attelabiden Aus Indien (*Curculionidæ*, Col.), by Edward Voss.

"The Punjab Irrigation Research Institute," Vol. II, No. 7, Nov. 1934—A Siltometer for Studying Size Distribution of Silts and Sands.

— Do. —Vol. IV, No. 7, 1934—Soil Deterioration in the Canal Irrigated Areas of the Punjab, Part I. Equilibrium between Ca and Na-Ion in Base Exchange Reactions.

— Do. —Part II. Relation between Degree of Alkalisation and Dispersion Coefficient in Deteriorated Soils (Vol. IV, No. 8, February).

Report of the Lac Research Institute for July 1935.

Report of the Indian Central Cotton Committee —(Its objects, activities and achievements.)

Dominion of Canada—Department of Agriculture :—

(1) Canadian Wool Grading and Marketing, by A. A. MacMillan, Livestock Branch, Bull. No. 181—New Series.

(2) The Cranberry Industry—Its Possibilities in Canada, by M. B. Davis with a Section on Insects affecting Cranberry, by F. C. Gilliatt and a Section on Cranberry Diseases, by K. A. Harrison (Bulletin No. 180—New Series)—Division of Horticulture.

(3) Capons and Caponizing by George Robertson and S. S. Munro—Bulletin No. 167, Division of Poultry Husbandry.

(4) The Gladiolus Thrips, by Alan G. Dustan, Bull. No. 151—Entomological Branch.

"The Review of Applied Mycology," Vol. XIV, Pt. 10, Oct. 1935 (Issued by the Imperial Mycological Institute).

"Proceedings of the Academy of Sciences of the U.P. of Agra and Oudh", Allahabad, Vol. IV, 1934–35.

— Do. —Session 1934–35 (Part V, Vol. IV).

— Do. —Part I, Vol. V.

"Medico-Surgical Suggestions," Vol. 4, No. 10, Oct. 1935.

"Report on the Administration of the Meteorological Department of the Government of India in 1934–35."

"Nagpur College Agricultural Magazine," Vol. 10, No. 2, Nov. 1935.

"Nature," Vol. 136, Nos. 3443–3446.

"The Journal of Nutrition," Vol. 10, No. 4.

"The Journal of Chemical Physics," Vol. 3, No. 11.

"Journal de chemie Physique," Vol. 32, No. 8.

"Russian Journal of General Chemistry," Vol. LXVII, Nos. 4, 6 and 7.

"Science and Culture," Vol. I, No. 7, December 1935.

"London Shellac Research Bureau, Technical Papers," Nos. 1–5.

"The Indian Trade Journal," Vol. CXIX, Nos. 1534–1537.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. V, Pt. III, September 1935.

"Transactions of the Faraday Society," Vol. XXXI, Part 11, Nov. 1935.

(The London Shellac Research Bureau.) "Abstracts bearing on Shellac Research Literature for the Period 1st Jan. 1928 to 31st Dec. 1933."

Researches on Desert Plants.

THE peninsula of Baja (or lower) California, by reason of its extreme aridity and isolation has developed many species of plants peculiar to it. Dr. Forrest Shreve of the Desert Laboratory of Carnegie Institute of Washington recently led an expedition into these regions to investigate (1) the influence of extreme aridity and of the proximity of the sea on the plant life, and (2) the contrasts between the floras of the Gulf and Pacific slopes and the differences between the same latitudes on the peninsula and the main land. The study of the flora itself is full of significance "with the long history of its origin from its ancestral stock, its migratory movements, and its constant need of either finding just the right life condition, or else adjusting itself to the one that it is able to find." An account of the results of this expedition is published in the *News Service Bulletin, Carnegie Institute of Washington*, 1935, **111, No. 26.**

In 1934 and for several previous years the area did not have any rain. In the beginning of 1935, there was rain for several weeks, and the larger plants were in leaf and blossom, and the ground was covered with a carpet of short-lived anuals. Most of the plants that impart character to the landscape of Baja California, are either found nowhere else or occur sparingly in Sonora. In sharp contrast with the plants that live in rainy climates where their only struggle is with one another, the desert plants do not interfere with other plants and their struggle is with the environment. This results in the development of a large number of types each of which is capable of winning the battle with the environment in a different way. The most outstanding plant in Baja California is 'Cirio' (*Idria columnaris*). Next comes 'torote' (*Pachycormus discolor*), the giant 'yucca' (*Yucca valida*), the large century plant (*Agare goldmaniana*), the giant cactus (*Pachycereus prongleü*), the 'Ocotolla' (*Fouquieria peninsularis*) and the 'creeping devil' (*Machærocereus eruca*). The cirio and the 3 species of ocotillo have developed a mechanism of withstanding desert conditions which is unlike that of cacti or, for that matter, any other plant in the world. The leaves which make the food materials necessary for the plant, fall off after the rainy season and the stems are protected from desiccation by horny layers of tissue impregnated with resin just beneath the barks.

Academies and Societies.

Indian Academy of Sciences:

November 1935. SECTION A.—S. SIDDIQUI AND Z. AHMAD: *Alkaloids from the Seeds of* Cassia absus, *Linn.*—Two water soluble isomeric quarternary bases, to be called chaksine and iso-chaksine have been isolated. S. SIDDIQUI: *Studies in the Conessine Series. Part I.—Isomerisation of Conessine and its Nor-Bases.*—The isomerisation effected through the action of concentrated sulphuric acid on the corresponding bases in the cold has been studied. Iso-conessine is about thrice as potent as conessine. R. P. DODWADMATH AND T. S. WHEELER: *Studies in the Chemistry of Chalcones and Chalcone-Oxides. I. Phenyl-(3·4-methylene-dioxy-styryl)-ketone.*—The effects of presence of other groups in the nuclei on the reactivity of chalcones and chalcone-oxides are reported. R. ANANTHAKRISHNAN: *Some New Features in the Raman Spectra of Carbon and Silicon Tetrachlorides.*—Octaves of fundamental frequencies and their differential tones are recorded. C. S. VENKATESWARAN: *The Fluorescence of Ruby, Sapphire and Emerald.*—The photo-luminescence of the natural crystals has been studied at room-temperature and a number of new bands are observed. T. S. WHEELER: *On the Theory of Liquids–V.*—A summarised presentation of the theory developed in the previous papers of this series. S. BHAGAVANTAM: *Raman Spectrum of Deuterium: II.—Intensity and Polarisation Characters.*—The results when compared with those calculated from the theory of rotational Raman scattering due to Manneback, show satisfactory agreement. P. S. REGE AND T. S. WHEELER: *A Study of the Benzoin Reaction-IV.—The Kinetics of the Benzoin Reaction in the Presence of Organic Solvents.*—With inert solvents the heterogeneous reaction is unaffected, but the homogenous reaction is decelerated. The action of hydroxy compounds is complicated, but on the whole, they accelerate the reaction. K. NEELAKANTAM, T. R. SESHADRI AND R. H. RAMACHANDRA RAO: *Pigments of Cotton Flowers.—Part II.—Uppam* (Gossypium herbaceum).—The main components are *gossypitrin and quercetin.*—A new glucosidic pigment and a small quantity of gossypetin have also been isolated. S. PARTHASARATHY: *Determination of Ultrasonic Velocity in 52 Organic Liquids.*—The velocity depends upon chemical constitution. The adiabatic compressibilities of all the liquids have also been calculated. A. N. KAPPANNA: *Kinetics of the Reaction between α-Brompropionate and Silver Ions.—A Heterogeneous Reaction taking place on the Surface of Silver Bromide.* S. W. CHINCHALKAR: *Magnetic Birefringence in Solutions of Organic Substances. Part I.*—Aromatic hydrocarbons containing two or more benzene rings have been studied.

November 1935. SECTION B.—MAKUND BEHARI LAL: *On the Morphology of a New Species of Monostome of the Genus* Notocotylus *Diesing*, 1839.—Specimens of monostomes have been described as a new species of the genus *Notocotylus*. A. C. JOSHI: *Secondary Thickening in the Stem and Root of* Stellera Chamæjasmæ *Linn.*—The anatomy of the stem and root of *Stellera Chamæjasmæ*, a member of the family Thymelæceæ, has been described. B. N. SINGH AND K. KUMAR: *An Analysis of the Influence of Season on Photosynthesis in the Tropics.*—Leaves adopt their structure and function according to the intensity of external factors, and the specific adoptability is mainly brought about by suitable changes in the internal factors investigated. MAKUND BEHARI LAL: *A Review of the Genus,* Notocotylus, *with Description of a New Trematode Parasite of* Mareca penelope *from Lucknow.*—A new form belonging to the genus *Hindia*, but differing from the known species of the genus in the number and arrangement of the ventral glands, the arrangement of the uterine coils and the anterior extent of the vitellaria, has been described. ALBERTO CARLOS GERMANO DA SILVA CORREIA: *The Marathas of Portuguese India.*—From an anthropometric point of view, the Marathas do not constitute a race, nor can they be considered as belonging to an only caste, though the majority of them may belong to the *chatria*. FROILANO DE MELLO: *New Hæmoproteids of Some Indian Birds.*—New species of hæmoproteids have been recorded. L. B. KAJALE: *The Female Gametophyte of* Alternanthera sessilis *R. Br.* A. C. JOSHI AND J. VENKATESWARLU: *Embryological Studies in the Lythraceæ. I.* Lawsonia inermis *Linn.*—The development of the normal 8-nucleate embryo-sac, the double and triple embryo-sacs and degenerations in the embryo-sac are described.

The U. P. Academy of Sciences:

September 1935. B. L. GULATEE: *On the Subterranean Mass-Anomalies in India.*—From the isostatic gravity anomalies in India, a distribution of mass anomalies expressed as a coating of normal crustal density in the reference surface has been determined. S. SUBRAMANIAN: *The Closure Property of Three Curves.* G. R. TOSHNIWAL AND B. D. PANT: *Measurement of Ionisation of the Kennelly-Heaviside Layer at Allahabad.*—The ionisation of the E region has been found in the month of April. The morning critical frequency was in the neighbourhood of 3.1 Mc./sec. at 8 A.M. The maximum critical frequency of 4.6 Mc./sec. was observed on the 18th April during the so-called "evening concentration". R. N. GHOSH AND L. P. VERMA: *On the Application of Heaviside's Operational Methods to the Solution of the Pianoforte Problem.* HRISHIKESHA TRIVEDI: *The Absorption Spectra of the Vapours of the Mono-Oxides of Copper, Iron, Nickel and Cobalt and the Determination of their Heats of Sublimation.* HRISHIKESHA TRIVEDI: *The Absorption Spectra of the Vapours of the Mono-Sulphides of Iron, Nickel, Cobalt and Copper and the Determination of their Heats of Sublimation.* S. S. JOSHI AND K. P. N. PANNIKAR: *The Variations of Viscosity during the Coagulation of Colloidal Aluminium Hydroxide by Potassium Chloride Solutions.*—The Progress of Coagulation at lowest concentrations of the electrolyte is sensibly discontinuous in the beginning. S. M. MEHTA: *Effect of Temperature on Borax Solutions in the Presence of Polyhydric Substances and Organic Acids.* RADHA RAMAN AGARWAL AND SIKHIBHUSHAN DUTT: *Chemical Examination of the Bark of* Terminalia Arjuna *Bedd. Part I.—The Isolation of Arjunin.*—An acidic principle, "arjunin" has been isolated, m.p. 192° C., $C_{26}H_{32}O_{11}$. SIKHIBHUSHAN DUTT: *Chemical Examination of* Glycosmis Pentaphylla *and the Constitution and Synthesis of its Active Principles.*—"Glycosmin" which is a crystalline glucoside

has been found to be a veratroyl derivative of salicin. N. R. DHAR AND S. K. MUKHERJEE: *Further Experiments on the Fixation of Atmospheric Nitrogen in the Soil and the Utilisation of Molasses as a Fertiliser.*—Molasses used as a manure, increases the yield of sugarcane to the extent of 36 per cent. M. B. MIRZA: Physaloptera Achari *N.Sp. from* Calotes versicolor *with a Short Note on Abnormalities in the Genus* Physaloptera.—A number of worms obtained from the stomach, small and large intestines, of *Calotes versicolor* found in Hyderabad, Deccan, has been described. HAR DAYAL SRIVASTAVA: *Studies on the Family* Heterophydae *Odhner*, 1911. *Part II.*—"*Four New Parasites of the Genus* Haplorchis *Looss*, 1899," *From Indian Fresh-Water Fishes with a Revision of the Genus.* B. P. PANDE: *Contributions to the Digenetic Trematodes of the Microchiroptera of Northern India. Part II.—Studies on the Genus* Lecithodendrium *Looss.* H. R. MEHRA: *New Trematodes of the Family Lecithodendriidæ Odhner*, 1911, *with a Discussion on the Classification of the Family.*—The account of a new genus *Exotidendrium* from the Indian gharial *Gavialis gangeticis*, and two new species of the genus *Eumegacetes* Looss from an Ashy Swallow-Shrike is given.

31*st October* 1935. S. C. DAMLE: *A Note on Sir Shah Muhammad Sulaiman's New Theory of Relativity.*—The degrees of accuracy of the two differential equations of motion obtained by Sir M. Sulaiman in Section V (Chapter I) of his theory dealing with Planetary Orbit were different. To maintain the same degree of accuracy, in both equations, the term containing the first differential coefficient of the distance from the centre should be retained in the first of the equations. When this term is retained in the first equation and other corrections introduced in the second, the value obtained for the rotation of the perihelion of mercury in one complete revolution is numerically one-sixth of the usually accepted value and in the opposite direction. N. R. DHAR AND S. K. MUKERJEE: *Use of Molasses inthe Reclamation of Alkali and Usar Lands.*—Reclamation of alkali soils is possible by the application of Molasses to the extent of 90–360 maunds per acre. Crops have been raised on such reclaimed soils with good yields. N. R. DHAR AND S. P. TANDON: *Influence of Temperature on the Fixation of Nitrogen by Azotobacter.*—Nitrogen fixation by Azotobacter takes place best at 35°C.; sunlight and azotobacter are the two potent agencies which serve to meet nitrogen requirements of tropical soils. A. M. D'ROZARIO: *On Two New* Xiphidiocercaria *from the Common Fresh-Water Snail,* Indoplanorbis exustus (*Deshayes*) *of the Northern India.*

5*th November* 1935. S. PRADHAN: *The Genetalia and Their Role in Copulation in* Epilachna indica (*Coccinellidæ: coleoptera*) *with a Discussion on the Morphology of the Genetalia in the Family.*—The structure, disposition and the mode of working of the muscles of the male and female genetalia of *Epilachna indica* were described. H. TRIVEDI: *The Absorption Spectrum of Hydrogen Bromide Molecule and its Upper Unstable State.*—An experimental verification of the author's theory of continuous absorption of a diatomic molecule by means of which it is possible to deduce the nature of the repulsive state. V. V. NARLIKAR AND D. N. MOGHE: *A Note on a General Line-Element.* D. N. MOGHE AND R. V. SASTRY: *The Field of a Non-Static Spherical Condensation.* SATYENDRA RAY: *The First Universal Principle of Sulaiman.* SATYENDRA RAY: *On Two Mutually Contradictory Interpretations of Einstein's Line-element by Sulaiman.* K. L. GUPTA: *On the Convergence and the Summability of the Conjugate Series of the Derived Fourier Series.* S. M. SANE AND A. B. SEN: *On Some Toluen Sulphonyl Esters of Phenols.* M. RAMAN NAYAR: *Variation of Physical Properties with Change in Concentration of Iodic Acid Solution.* UMAKANT SHUKLA: *Necessary and Sufficient Condition for the Equality of*

$$\frac{d}{dy}\int_a^b f(x.y)dx \text{ and } \int_a^b \left[\frac{d}{dy}\{f(x.y)\}\right]dx$$

B. M. GUPTA: *On the Relationship Between the Soluble Fatty Acids and the Potash Equivalent of Acids giving Barium Salts.* A. C. CHATTERJI: *Influence of Lyophillic Colloids on the Wettability of Naphthalin.*—The power to wet and the protective effect of lyophillic colloids bear a very close relation to each other, both being due to absorption of the colloid by the respective particles.

Indian Chemical Society:

October 1935. HANS KRALL AND RAMESWAR DAYAL GUPTA: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad,-N-C-S—. Part I.—Aniline Thiocyanate.* SANATSARAN MEHTA AND HANS KRALL: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad.-N-C-S-.—Part II.—Action of Hydrolytic Agents on Phenylthiocarbamide.* SANATSARAN MEHTA AND HANS KRALL: *The Phenylthiocarbamides.—A Contribution to the Study of the Triad. —N-C-S-.—Part III.—Action of Nitrous Acid on Phenylthiocarbamide.* DINES CHANDRA SEN: *Studies in the Camphor Series.—Part I.* L. MCMASTER AND C. R. NOLLER: *The Formation of Amides from Nitriles by the Action of Hydrogen Peroxide.* H. K. SEN, KANAILAL ROY AND PANKOJ ROY: *Note on a Routine Gas Analysis Apparatus.* SISIR KUMAR GUHA: *Studies in Indigoid Dyes.* UMAPRASANNA BASU AND BASUDEB BANERJEE: *Synthesis in the Pyridine Series. —Part II.* NIRMALAPADA CHATTERJEE: *The Coagulation of Ferrocyanide Sols Containing Varying Amounts of Potassium Ferrocyanide.* B. B. DEY: *Preparation of Resorcinol Monomethyl Ether* (*A Correction*).

Asiatic Society of Bengal:

November 1935. (MEDICAL SECTION). *Live fishes inspected in the food and air passages of man.*—At the recent Meeting of the Medical Section of the Asiatic Society of Bengal, Dr. S. L. Hora of the Indian Zoological Survey addressed the members on the recent Indian cases of live fish found in the human pharynx and air passage. The Surgical aspect of such cases was presented by Lt.-Col. B. G. Mallaya. Dr. E. W. Gudger had reported 38 cases of live fish impacted in the pharynx and air passage, which were compiled from records covering the period from 1567 to 1933. Nearly 32 per cent. of such accidents are

said to have occurred in India and Burma. Dr. Hora instituted further enquiries into such calamitous occurrences and has collected information regarding 19 more cases; altogether there have been 31 authenticated reports of such accidents in India. On mapping out the distribution of these misfortunes according to the provinces where they occurred and according to the types of fish producing them, Dr. Hora has placed the latter in the following order of delinquency.—*Anabas testidinens* responsible for 17 cases; *Colisa Fasciatax*, 4; *Mustacembelus*, *Nandus* and *Cynoglossus*, 1 each; 7 undetected. Out of the 19 recent cases, the Madras Presidency claims 6, Assam 5, Burma and Bihar and Orissa 3 each, Bengal and Bombay Presidency 1 each. In Dr. Gudger's Indian cases, the offending fishes were found in the pharynx of the victims; Dr. Hora reports that in 13 cases, fishes were lodged in the food passage and in 6, he found them insinuated in the air passage: more than 63 per cent. of these cases proved fatal.

Dealing with the surgical treatment of fish obstruction Lt.-Col. Mallaya observed that the condition of the patient and the position of the fish must determine the line and the extent of operative interference. A foreign body blocking the vital passages must rapidly produce suffocation and Dr. Mallaya suggested that in view of the extreme urgency of all such cases, a tracheotomy or pharyngotomy performed even with a pocket knife would relieve respiratory embarrassment, and in other less desperate cases where only the nasopharyngeal passage is affected, perhaps a pair of long forceps might suffice to provide relief. The removal of the fish from the passages must be at once delicate and difficult for the obvious reason that the animal may remain alive for some time and may be bristling with spines. Accidents of this kind must be due to follies. Further history of such cases of live fish being impacted, regarding age, sex and occupation of the victims must throw light upon the immediate causes of accidents.

Meteorological Office Colloquium, Poona:

Four meetings were held during November 1935. At the first of these held on the 4th, Father M. Selga of the Phillippines Weather Bureau addressed the gathering on "Typhoons and Weather in the Phillippines" and described the organisation of the Weather Service in the Islands; also, Father R. Raphæl of the St. Xavier's College, Bombay, who was in Quetta at the time of the big earthquake, gave an account of some personal impressions in respect of the same. The programme at the three remaining meetings was as follows:—

12-11-35.—Mr. P. K. Raman: "Some recent work on problems relating to the thermal balance at the earth's surface."

19-11-35.—Dr. S. K. Banerji: "Calculation of velocity and acceleration of a system of isobars."

26-11-35.—Mr. M. S. Katti: "Some recent work on meteorology in relation to the soil."

University and Educational Intelligence.

Andhra University:

Applications will be received by the Registrar Andhra University, Waltair, for the following posts in the University Colleges:—

Professor of Economics.
Professor of Politics.
Professor of Pure Chemistry.
Professor of Applied Chemistry.

Salary Rs. 800—50/2—1,000.

The Syndicate will be prepared to consider higher terms in exceptional cases. Further particulars can be had from the Registrar.

Sir J. C. Coyajee, Professor of Economics, has resigned his appointment. He was Professor of Economics for nearly three years.

A Diploma course in Librarianship has been introduced in the University.

The M.A. (Hons.), M.Sc. (Hons.), and Ph.D. degrees were awarded for the first time this year, to candidates for research work done by them.

Allahabad University:

Pandit Iqbal Narain Gurtu was elected Vice-Chancellor of the Allahabad University, at a meeting of the Council held on the 4th December.

Aligarh Muslim University.

The Academic Council of the Aligarh Muslim University decided at its meeting held on 13th November to accept the thesis submitted for the Ph.D. Degree in Physics by Mr. Mohd. Jan Khan. As examiners Sir C. V. Raman, Dr. W. Jevons, Imperial College, London, and Prof. R. Samuel, Aligarh, have been appointed. The thesis comprises two parts. In part I, the candidate has worked out the absorption spectra of a number of polyatomic molecules and shows that the ground state of molecules formed by a central atom in a higher state of valency does not arise from the ground state of a molecule formed by atoms of lower valency but from an excited level. The second part deals with the spectra of SeO and SeO_2, the vibrational analysis of which is given. The constants of these molecules show a close correspondence. Both these results clearly indicate a strong localisation of the bonds.

Benares Hindu University:

New Appointments.—In the new session which commenced in July, eleven new appointments were made. The following are some of the important ones:—

(1) Rao Bahadur K. V. Rangaswami Aiyangar, M.A. (Madras), appointed Principal of the C. H. College of Arts and University Professor of Economics.

(2) Dr. S. K. Belvalkar, M.A. (Bom.), Ph.D. (Harvard), I.E.S., appointed University Professor of Samskrit.

(3) Dr. P. N. Roy, M.A. (Cal.), D.Litt. (Rome), appointed Professor of Modern European Languages.

(4) Dr. Mrs. Indumati B. Adarkar, M.B.B.S. (Bom.), D.L.O., M.R.C.S. (London), appointed Lecturer in Domestic Science for the Women's College.

Faculties.—At the Annual Meetings of the Faculties held on November 29 and 30, 1935, the following gentlemen were elected Deans :—

Faculty of Law : The Rt. Hon'ble Dr. Sir Tej Bahadur Sapru, K.C.S.I., M.A., LL.D.
Faculty of Arts : Prof. P. B. Adhikari, M.A.
Faculty of Science : Prof. P. K. Dutt, M.A. (Cantab.)
Faculty of Oriental Learning : MM. Pandit Pramatha Nath Tarkabhushan.
Faculty of Theology : Pandit Vidyadhar Gaud.
Faculty of Ayurveda (Medicine and Surgery): MM. Kaviraj Dr. Gananath Sen, M.A., M.D., L.M.S.

Academic Questions.—The University was one of the earliest in the country to start a number of technical and professional courses which have hitherto been under the Faculty of Science. With a view to greater efficiency the Senate has proposed the establishment of a separate Faculty of Technology. The necessary Regulations have been framed and submitted to the Visitor for sanction. The Senate has also under consideration the introduction of a diploma course in Pharmaceuticals.

University Library.—The University Library is now housed in a commodious and magnificent building constructed at a cost of Rupees Three Lakhs which was received as a donation from H. H. The Gaekwad of Baroda. During the year 1934–35, 8,547 volumes were added bringing the grand total of books to about 80,000. The new accession includes 5,725 volumes valued at Rs. 50,000 and received as a gift from the Kanju Mulji Charitable Trust of Bombay.

The University Training Corps.—The corps has returned from the Annual Camps of the Battalion held at Bareilly from Nov. 1 to 15. It won the Efficiency Cup for the ninth time in succession and annexed several other prizes and trophies. Besides providing armoury, parade ground and residential quarters the University has recently constructed a 400 yards' classification Shooting Range at a total cost of Rs. 6,000.

University of Bombay:

Royal Institute of Science.—Dr. Mata Prasad, Professor of Inorganic and Physical Chemistry, has been elected a Fellow of the National Institute of Sciences, India.

The 1st annual meeting of the Indian Academy of Sciences, was held here from 18th to 20th of December. It was opened by H. E. the Governor of Bombay. Mr. V. N. Chandavarkar, the Vice-Chancellor of the Bombay University, was the Chairman of the Reception Committee.

Calcutta University:

The Senate of the Calcutta University has donated Rs. 5,000 to the Indian Institute of Medical Research, out of the Sir P. C. Roy Fellowship Fund, and sanctioned a grant of Rs. 1,200 to Dr. G. N. Roy, Professor of Chemistry, Carmichæl Medical College, to enable him to carry on research on Epidemic Dropsy.

University of Mysore:

1. The Senate held its ordinary meeting for the year on 21st November, 1935. At the meeting, the Senate resolved to recommend the conferment of the Degree of Doctor of Laws on Rajasabhabhushana Diwan Bahadur Sir K. P. Puttanna Chetty. A proposal to declare the results of the Master's Degree examination in two classes (first and second) was referred to the Academic Council. A proposal to institute a section providing balanced diet in hostels was discussed. The University authorities will further consider the proposal.

2. Dr. A. Subba Rau, B.A., D.Sc. (Lond.), F.R.M.S., Professor of Physiology, Medical College, was elected by the Senate of this University as its representative on the Court of the Indian Institute of Science, Bangalore, for the period, 1936–40.

3. The following Extension Lectures were delivered :—

(i) Mr. Devudu Narasimha Sastry, M.A., on (*a*) "Kalidasana Sandesa"; (*b*) "Karnataka Samskruti"; in Kannada at Nanjangud, Mysore and Chickballapur.
(ii) Mrs. Iqbalunnisa Hussain, B.A., Dip.Ed. (Leeds). on (*a*) "My experiences in an English University" in English at Bangalore and Mysore; (*b*) "Education of Muslim Women" in Urdu at Bangalore and Channapatna.

4. Mr. K. S. K. Iyengar, B.A. (Cantab.), Professor of Mathematics, Central College, proceeded on leave for one month and 18 days from 6th November, 1935.

Central Board of Education:

FULL LIST OF MEMBERS.

Ex-officio.—(1) Sir Girja Shanker Bajpai, Member-in-charge of the Department of Education, Health and Lands (Chairman), and (2) Sir George Anderson, Educational Commissioner with the Government of India.

Nominated by the Government of India.—(3) Sir T. B. Sapru, (4) Sir Akbar Hydari, (5) Dr. A. H. Mackenzie, (6) Right Rev. G. D. Barne, (7) Lady Grigg, and (8) Srimati Rajkumari Amrit Kaur.

Elected by the Council of State.—(9) Sir K. Ramunni Menon.

Elected by the Legislative Assembly.—(10) Dr. Ziauddin Ahmed, and (11) Dr. Bhagwandas.

Nominated by the Inter-University Board.—(12) Mr. Shyamaprasad Mookerjee, Vice-Chancellor, Calcutta University, (13) Sir S. Radhakrishnan, Vice-Chancellor, Andhra University, and (14) Dr. R. P. Paranjpye, Vice-Chancellor, Lucknow University.

Representatives of Local Governments—Either the Minister of Education or his deputy, Director of Public Instruction or his deputy.—(15) The Director of Public Instruction, Madras, (16) the Director of Public Instruction, Bombay, (17) the Minister-in-charge of Education, Bengal, (18) Sir J. Srivastava, Minister of Education, United Provinces, (19) the Director of Public Instruction, Punjab, (20) Dr. Ba Maw, Minister of Education, Burma, (21) the Minister of Education, Bihar and Orissa, (22) Mr. B. G. Kharpade, Minister of Education, Central Provinces, (23) the Director of Public Instruction, Assam, and (24) the Director of Public Instruction, North-West Frontier Province.

Reviews.

"Mathematics and the Question of Cosmic Mind," with Other Essays. By C. J. Keyser. ("Scripta Mathematica", Yeshiva College, Amsterdam Avenue and 186th Street, New York, U.S.A.) 1935. Pp. 128. 75 cents.

This book is No. 2, in the Scripta Mathematica Library series of which No. 1 was reviewed in these columns previously. According to the author the book, at least the greater part of it, is written for those who should like to think, and not for the multitude who are satisfied with being merely told. The volume is composed of six essays,—all reprints,—two being popular expositions of the mathematical method and one a popular discussion of that most discussed subject—whether the external world is real. In the essay on "Mitigating the tragedy of our modern culture" the author puts in a powerful plea for more earnest attempts on the part of the specialists to popularise their work so as to reach "the intellectual laymen" and reviews the notable attempts of Reichenbach, Weyl, Lewis, Levy, Jeans and Eddington. It certainly gives us great pleasure to add to these the name of the eminent author of these essays. In the essay dealing with Law (he calls it legal science), we are shown how mathematising will benefit the subject immensely though there are obvious limitations of a formidable character. The last essay is merely an appreciative article on the life of the late Prof. W. B. Smith, a great mathematician and a versatile scholar.

The book is well got up notwithstanding the misprints which occur (*e.g.*, on pages 56, 89, etc.) and is very readable, the language throughout being frankly journalistic. The purpose of the promoters of the movement is eminently served by the two books so far issued and we may confidently look forward to more illuminating works of a similar nature in future. As No. 1 in the series bears the name *Poetry of Mathematics and Other Essays*, it would not have in the least been inappropriate if this had been named *Meaning of Mathematics and Other Essays*.

B. M. N.

Mechanical Properties of Matter. By S. G. Starling, B.Sc., A.R.C.Sc., F.Inst.P. (Macmillan & Co., Ltd., London.) 1935. Pp. viii + 336. Price 6*sh*.

There are but a few text-books on Properties of Matter at present available in English and a new book by the author of the much-used *Electricity and Magnetism* is a welcome addition. The book comes entirely up to our expectations and has the same conciseness and clarity that distinguish the other books of the author. Though primarily meant for Higher School Certificate and Intermediate students, such free use of simple Calculus has been made that with a very few additions here and there, *e.g.*, in connection with Gravitation, the book will meet the utmost needs of the B.A. and B.Sc. Pass students of our Universities. In fact the chapters on "Flow of Liquids and Gases" and "Waves" contain more information than is usually required from such students and help to put them in touch with useful results in Hydrodynamics deduced in a simple way. The large number of graded exercises appended to the several chapters will serve to give the student a thorough grounding and the really numerous worked examples are models which can be entirely recommended.

Exception has to be taken, however, to one or two features in this otherwise excellent book. The half-hearted introduction of vector notation leads to some equations which are meaningless. The fault is mostly due to introducing division by a vector as if it were an ordinary scalar. Thus $\frac{u_2'-u_1'}{u_1-u_2}=e$ on p. 30, $f \times s$ meaning fs on p. 31 and $\frac{\mathrm{v}^2}{r}$ on the same page will lead the student to an unwarranted liberty in operations with a vector. On p. 77 $\frac{v^2}{r}$ is called the radial acceleration: this is misleading. $\frac{v^2}{r}$ is the acceleration along the normal which happens to coincide with the radius in the case of the circle. The equation $\frac{d\mathrm{v}}{dt}=r\frac{d\omega}{dt}+\frac{\mathrm{v}^2}{r}$ on p. 76 would mean that along the radius there are two accelerations $r\frac{d\omega}{dt}$ and $+\frac{\mathrm{v}^2}{r}$ both of which are false conclusions. The introduction of the vector notation is a progressive step, but the little addition that would make the notation consistent is not beyond the grasp of the students who use the book, and could easily be introduced. On p. 96 there is a misprint reading "holes are drilled the bar" and on p. 175 we once read "liquified". The

correction for the buoyancy of air in weighing should be $m_1 = m_2\left(1 - \frac{\delta_3}{\delta_2} + \frac{\delta_3}{\delta_1}\right)$ while on p. 165 it is written as if $m_1 = m_2\left(1 - \frac{\delta_3}{\delta_1}\right)$.

These small blemishes are indicated with the sole idea of making the book as unexceptionable as possible, for we may be sure that such a good text will see numerous editions and will serve generations of students. We have no hesitation in recommending the book to the Pass students of our Universities. The low price is most inviting.

T. S. S.

Elements of Strength of Materials. By Messrs. S. Timoshenko and Gleason H. MacCullough. (Messrs. Macmillan & Co.) 1935. Pp. 350. Price 14*s*.

The authors have brought out an exceedingly useful book. There are a large number of text-books on the subject but the presentation of the subject by the authors is so good that one's interest to read the book is increased as he proceeds and at the same time, due to the inclusion of alternative methods of solving many of the problems the subject is made very clear. The authors have in addition included at the end, chapters on " Energy of Strain " and on the various modern strength theories which will give just an idea to the students about the practical realities of the strength of materials and working stresses. But in the chapter on riveted joints while discussing the failures of joints by various causes, they have recommended that the distance between the centre of the hole and the edge of the plate should be between $1\frac{3}{4}$ to 2 times the diameter of the rivet, while the British practice recommends only $1\frac{1}{2}$ times the diameter. Again, for double shear the resistance is assumed to be double that for single shear, while the usual practice is to assume only $1\frac{3}{4}$ times that of single shear resistances, since it is not possible to ensure uniform distribution of loads. The authors could have, with benefit, included the formulæ for the design of rivets for given thickness of plates and design of cover plates in the case of butt joints, and also graphical determination of pitch by band method. Except for these shortcomings the book is a very good one and can be used as a text-book in the Colleges and Schools of Engineering.

The Publishers must also be congratulated on the neat printing and get-up of the book; there are very few errors and the printing is such as not to strain the eyes.

E. K. R.

Mercury Arc Rectifier Practice. By Mr. F. C. Orchard, A.M.I.E.E. (Chapman & Hall, Ltd., London.) 1935. Pp. 224. Price 15 *sh.*

This book deals clearly and concisely with a subject of growing importance, and will be found equally useful by students as well as practising engineers. The author explains in simple terms, with the help of clear diagrams, the principles underlying the action of the rectifier, its evolution and construction. The writer also deals in a very practical and comprehensive manner with the installation, operation, maintenance and testing of rectifier sub-stations. The chapter on grid control indicating, as it does, some important applications and possible lines or future development, adds greatly to the value of the book. The diagrams are excellent. The concluding chapter gives the relative advantages and disadvantages of the rectifier as compared with rotating machinery for sub-station work. The appendix contains some useful tables and a bibliography is added.

C. A. K.

Inorganic Colloid Chemistry, Vol. II. The Hydrous Oxides and Hydroxides. By H. B. Weiser, Professor of Chemistry at the Rice Institute. (John Wiley & Sons.) 1935. Pp. 429. Price 23/6.

The book deals with the methods of preparation, the properties and the uses of oxides and hydroxides in the colloidal condition. Ten years ago the author published a book on the Hydrous Oxides. The present volume, however, is not a mere revision of the earlier work. As stated by the author in the preface, most of the chapters have been entirely rewritten embodying the latest developments in this rapidly expanding branch of physical chemistry. The numerous observations recorded in the book have been examined critically and special emphasis has been laid on those aspects of the study of colloidal oxides as have led to the development of colloid chemistry on the theoretical as well as the applied side.

The first chapter is introductory in nature and deals in general with the preparation and properties of hydrous oxides and gels. The oxides are studied in detail in the subsequent chapters. The treatment of the hydrous oxides of iron, aluminium, chromium and

silicon is particularly exhaustive. The last four chapters deal with the technical applications of the hydrous oxides in mordant dyeing, mineral tanning and water purification.

The book is to be welcomed as a valuable reference work by colloid chemists and will be equally useful to the teachers and students of chemistry as the information is presented in a clear manner — characteristic of all the publications by Professor Weiser.

B. S. RAO.

Colloids in Agriculture. By C. E. Marshall, M.Sc., Ph.D. (Edward Arnold & Co., London.) 1935. Pp. 184. Price 5*s*.

The publication of this book is a sign of the increasing extent in which the teachings and methods of physical chemistry and of colloidal science are being drawn upon in building up the scientific basis of the studies of soil. Dr. Marshall's work on soil problems specially that on the X-ray analysis of clay minerals is well known and the book fulfils every expectation as to a clear, critical, concise and accurate exposition of the subject-matter. The book has been written with an eye to the requirements of "country organisers, district lecturers and rural instructors—indeed, to all who are engaged in scientific agriculture and who are interested in the application of our latest knowledge to their field work and their teaching" as also of "agricultural students"; in other words, both for instructors and students. It serves this purpose most admirably. In the short compass of 184 pages, demy size, the subject-matter is treated under the heads, the nature of colloids, the formation of colloids, the properties of small particles in suspension, the properties of molecules at surfaces, ions at surfaces, soils and gels, the mineral colloids of soil, the organic colloids of soil, colloids in soil formation processes, colloids and soil texture, some colloidal materials present in living organisms, colloidal architecture in biological structures, milk and milk products as colloidal systems, smoke damage and plant protection. The book incorporates the latest information though naturally it is possible to indicate only the broader principles in so short a space. It has also the merit of using a lucid and descriptive style and avoiding such intricacies as are unsuitable for the class of readers the author has in view. It seems, however, that the student, in order to intelligently grasp the subject, must have a good knowledge of the fundamentals and of more complicated allied phenomena which would supplement the skeletal framework given in the book. This need is met by the author by the addition of lists of reference books at the end of each chapter with short notes for guiding the student.

The appearance of this book following in close succession those of Professors Robinson and Comber and the latest edition of Sir John Russell's well-known book now places at the disposal of English-knowing students of soil science an excellent account of the present position of our knowledge and tendencies of the development of soil science.

The reviewer was particularly interested to notice that the book correctly reflects the present position of our knowledge regarding the following:

(*a*) Coagulation by electrolytes seldom takes place at the isoelectric point and quite often at a cataphoretic speed higher than that of the particles of the sol not mixed with an electrolyte. It may be mentioned that during the aggregation of the particles the cataphoretic speed most often rises and then sharply falls when the colloidal solution loses a visible homogeneous appearance. The text-books on colloids give a wrong picture in this respect.

(*b*) An electric double layer may be formed on the surface of a particle by the adsorption of ions as distinct from the dissociation of adsorbed or surface molecules already present. It may be stated that this idea of dissociation of surface molecules requires to be supplemented by an answer to the question as to why a part of the dissociated molecules remains attached to the surface and the other part is, relatively speaking, more able to diffuse into the liquid and give rise to the double layer. The use of the terms, mobile ions and primary adsorption, is also specially welcome to the writer. They give a better idea of the conditions obtaining in the double layer. Perhaps the mention of the electrical adsorption would have given a more definite picture of the double layer. The subjects of the adsorption of ions, and of base saturation capacity, and the degree of saturation in relation to texture, pH and the Hissink, T, S, and V values might have been treated somewhat more in detail.

No student of agriculture can afford to do without a copy of this book.

J. N. M.

Annual Review of Biochemistry, Vol. IV. Edited by James Murray Luck. (Annual Review of Biochemistry Ltd., Stanford University P.O., California, 1935.) Pp. vii + 639. Price $ 5·00.

The policy adopted by the *Review* is neither to encompass the whole field of Biochemistry within a single volume nor to adhere rigidly year after year to a given list of topics, but to discuss a bunch of papers relating to a definite aspect of Biochemistry or to a certain point of view. The chemistry of proteins and amino acids reviewed by Professor Cohn is a fine example of how stray and apparently unrelated papers have been marshalled and integrated to yield a comprehensive and a stimulating review of the subject from a physiochemical standpoint.

The Editors have been fortunate in securing the services of several authorities in their respective fields and this circumstance while raising the prestige of the *Review*, renders it highly informative and inspiring. Such reviews are useful in acquainting the reader with the processes which lead to the creation of new knowledge and by way of example particular attention may be drawn to the reviews on Plant pigments by Kuhn, Alkaloids by Robinson, Growth substances in plants by Thimann, Vitamins by Harris and Chemical embryology by Needham. While the Editors of the *Review* have provided us such a substantial quantity of useful information which will stimulate and inspire further inquiry, it may be considered ungrateful if we remark that some of the reviews read more like an assemblage of chemical abstracts. In future, with enlistment of the co-operation of the reviewers it should be possible to achieve the difficult task of maintaining a uniformly high standard and quality for all the branches of the subject reviewed.

The fact that the enterprise after the introductory three-year period, has been established as a non-profit corporation, is a fine testimony to the excellence, usefulness and popularity of the *Review*. It is a volume which will be found indispensable to every research worker.

M. S.

Cane Sugar Factory Control. By K. C. Banerji, F.S.T.A. (Indian Press, Ltd., Allahabad.) 1935. Pp. 436. Price, Foreign £ 1 ; Indian Rs. 13–8–0.

This book is divided into two parts. The first part contains fifteen chapters on the technical methods of chemical control and their principles, special reference being made to the recommendations of the "Uniformity Committee". The second part is a collection of 42 tables useful in the routine as well as special factory control work.

The official definitions of the "Uniformity Committee" are given in the first chapter with the author's explanatory notes wherever necessary. A separate chapter on sampling and weighing has been written. The methods of drying for moisture determination are treated in detail. The chapter on polariscope contains a concise explanation of the principles of polarisation, and a description of the different instruments and accessories.

Lane and Eynon's method for reducing sugars has been recommended for all determinations except for high grades for which Low's method should be employed. The description of both the volumetric and gravimetric methods for reducing sugars is full but the argument for including, in the same chapter, methods of ash determination is not convincing.

For mill control purposes, Noel Deerr's formula for the weight of mixed juice any other unknown quantity in the fundamental equation, has been favoured. The author has given a detailed description of Deerr's algebraic theory and concludes the chapter with a numerical example and the standard milling formulæ.

The chapter on boiling house control is well written. It contains the s.j.m. and the Winter-Carp-Geelig's formulæ and the different expressions for the "recovery" and "yield". Calculation is amply illustrated by numerical examples.

In spite of the numerous errors in the text, which are of a minor character and are incidental to a first publication, the subject-matter of the book is very well arranged and the finish given to it is quite up-to-date. The illustrations are apt and the compilation of tables quite comprehensive. With the latest informations like the International Committee recommendations, pH control, method of colloid estimation, etc., the book satisfies a real need of every sugar factory laboratory.

G. G. RAO.

The Bombay Grasses. By E. Blatter, S.J., Ph.D., F.L.S. and C. McCann, F.L.S. (*Scientific Monograph* No. 5, of the Imperial Council of Agricultural Research.)

The late Father Blatter was one of the most untiring of workers and one of the most prolific writers in the field of systematic botany in Western India for many years. Mr. McCann had during a long period collaborated with Father Blatter and this work, which appears above their joint names, represents an enormous amount of very careful labour in the field, the herbarium and the library. The bibliography is a complete list of references to grasses. The authors have wisely followed Stapf in the definition and sequence of the various divisions of the grasses and in this respect and others the book is up-to-date. The ecological side has not been forgotten and economic and medicinal uses are also mentioned, where known. A very valuable part of the book is composed of the excellent drawings done by Mr. R. K. Bhide, up till recently the Economic Botanist in the Nizam Dominions and previously a member of the Bombay Agricultural Department. A dissection under the dissecting microscope and a reference to these plates will often enable a quick diagnosis to be made—a diagnosis which might otherwise take a long time, particularly if some of the older descriptions have to be used for the identification of grasses.

As many of the grasses mentioned in this work are distributed widely over India, it is certain that the book will be in great demand by those who are interested in grass throughout the whole of the Indian Empire. While the book is primarily botanical and systematic, it will be found useful to those into whose spheres grasses come from the practical point of view, the workers in the Agricultural Department, the Forest Department, the Revenue Department, the scientific sections of Indian Universities and Colleges and the growing number of lovers of nature who are prepared to undergo the small discipline necessary to be able to follow a botanical description. A regrettable defect in this work is the binding, which is likely to give way at an early date and throughout the book the printer's ink appears to have been occasionally smudged.

W. B.

Birth Control To-Day. By Dr. Marie Carmichael Stopes. (John Bale Sons & Daniel Son, Ltd., 83–91, Great Tichfield Street, London, W. 1) 1934. Second Edition. Pages 237.

Since the publication in 1919 of *Wise Parenthood* Dr. Stopes has been contributing voluminously to the literature on contraception. In all her writings she has, to quote her own words, created a background of argument and sentiment behind the scientific exposition. The present book, which is addressed to those converts to Dr. Stopes's doctrines, who want a practical solution to their problems, is entirely devoid of sentiment and presents merely the essential facts about birth control in all its aspects.

At the outset the author cautions against those who, wilfully disregarding the fundamental teachings of contraception, resort to unnatural methods, and as a consequence wreck their own lives and are a menace to society as a whole. The book begins with laying before the reader the case for birth control and the relevant physiological facts. A unique feature of the book is that side by side with the orthodox methods some very efficient and cheap makeshifts have been indicated. It is very gratifying to note that in this particular, if in no other, the author's claim for the usefulness of the book to the less favoured section of our society is thoroughly justified.

The rapid spread of birth control knowledge in modern times has brought in its trail certain baneful results. In the hands of the ignorant, the methods of birth control are at once dangerous and undesirable. The author is keenly alive to this, and has, in a special chapter, dealt in an admirable manner, with the so-called "dangerous" methods. This section above all others must form the subject for serious study. That it is impossible to divorce sentiment entirely from such a human consideration as contraception is evident from the subject-matter of the ninth chapter; here the author has answered certain questions arising in the minds of persons troubled by qualms of conscience. These we hope will be useful in setting at rest all doubts of honest thinking folk. The value of the book is considerably enhanced by the inclusion, at the end, of some useful information about the working of Birth Control clinics and directions for the obtaining of first-hand knowledge. A short note appears about the legislation governing the practice of Birth Control by individuals and at clinics.

Admittedly it is the right of every individual to be equipped with the knowledge to control his most vital function and the publication of this book by a recognised authority is very opportune at a time when

the Public Health Commissioner in India has put up a plea for the control of population in this country.

C. N. R. R.

The Snakes of India. By Lieut.-Colonel K. G. Gharpurey, I.M.S. (The Popular Book Depot, LamingtonRoad, Grant Road, Bombay.) 1935. Pp. x + 165. 76 Figures. Price Rs. 3.

Gharpurey's *Snakes of India* is a popular book giving general information and useful knowledge about the various common snakes found in our country and is written in a simple, lucid style, calculated to make the subject both attractive and comprehensible to the layman. Beginning with a short Introduction, preceded by a page of "Errata" and quotation from Arnold's *Indian Idylls*, it comprises as many as 36 chapters dealing with almost every aspect of Indian Ophiology. The last chapter is by R. K. Golikere and makes a "World Survey of Dangerous Snakes". There are 76 figures, most of which are photographs. It is really unfortunate that in many cases the author has had to depend on photographs made from distorted, preserved specimens and has not been able to secure characteristic pictures of *live* specimens. A preserved specimen loses the pose, attitude and bodily configuration characteristic of a living one, and a picture made from it cannot give a faithful idea to the reader.

Here and there, though rather rarely, one comes across in Gharpurey's book facts which appear to be imprecisely expressed; but a book of such wide scope cannot be absolutely without faults and we can conscientiously recommend it to those who are interested in the subject.

As examples, we might mention that the author says, "in the majority of snakes, the female lays eggs *in the sun*" (p. 5; italics ours), a statement which we cannot endorse. On p. 6 he says that "the safest way to hold a snake is by its tail at arm's length. Then it may wriggle but cannot bite or twist round the arm." One might mention that snakes are supple creatures and even though they are gripped by the tail and kept at arm's length from the body, they can raise up their front half of the body by making a sort of loop and bite at one's hand. What the snake-charmers do is not only gripping a snake as described by the writer, but also continually giving it a gentle shake to prevent its reaching up.

On p. 49, Gharpurey says, "Snake-charmers ....are adroit in catching snakes. They are quick, and as soon as they see a snake, they grab it just behind the head, so that it cannot bite." The reviewer has accompanied snake-charmers once annually for the last nine years on snake-hunting in the jungles, but he has yet to see a snake-charmer who can grab a poisonous snake just behind the head, as soon as he sees it. If he did it, in all likelihood he would not live long to exhibit that snake to admiring spectators. Usually, the snake-charmer—and not all snake-charmers—can catch cobras fresh from the jungle—drags out a cobra from its hiding-place by the tail, keeps it at a yard's distance from his body, places a stick on its neck and by moving the stick carefully round, "pins" the head firmly to the ground. Then and only then it is that he ventures to grip its head in his hand. With a krait the process is doubly more difficult and it is only the most adroit snake-charmer who would try his hand at it.

On p. 4, the author says that "the bifid tongue probably conveys the sense of smell to the two nostrils". While this may be the usual idea, we should like to point out that one authority at least (Ditmars, 1922) believes that "*snakes hear with their tongues*" and that "the delicate, nerve-supplied tips of this wonderfully specialised organ are highly sensitive to vibrations from even slight sounds."

B. C. M.

Manual of Human Physiology. By Sir Leonard Hill, M.B., LL.D., F.R.S., HON.A.R.I.A. (Edward Arnold & Co., London.) 1935. Fourth Edition, 484 pages with 186 diagrams. Price 6*s*. 6*d*.

The fourth edition of this excellent and popular manual of Human Physiology follows closely the pattern of the preceding one but is modified in accordance with recent discoveries. An important feature of the book is the inclusion of a much-needed chapter on Reproduction; it also contains suggestions for experiments with very simple and inexpensive apparatus. It is as complete and clear an account of Human Physiology as could be written for the use of "students training to qualify as teachers; for nurses undergoing hospital training and for the higher classes of schools and polytechnics". The treatment of the subject on the whole is such that it will be of great help to any

one interested in the teaching of elementary Physiology. There is an adequate index.

A. S. R.

Further Experiments upon the Water-Gas Process. By J. G. King, B.H. Williams, and R. V. Thomas. (Department of Scientific and Industrial Research. Fuel Research. Technical Paper No. 43, 1935.)

This publication is a sequel to the earlier studies in which methods were described to study the carbon and thermal balances in producer-gas process.

The investigations described in this paper are arranged in four parts. The first part is devoted to a study of the causes of clinker formation in the generator and the devices employed to minimise the accumulation of clinker, especially such as would adhere firmly to the walls of the generator and cause serious inconvenience. Observations of the distribution of temperature at various regions of the fuel-bed, as well as of the velocity of flow of gas at the sides and central regions of the generator provided data which suggested (*a*) that while charging the generator, a device should be employed to keep the larger lumps of coke in the centre and let the coke breeze pack the sides, and (*b*) that the grate should be so arranged that air flows into the fuel-bed at the centre of the grate. These two devices helped to keep the zones of high temperature in the fuel-bed in the centre, and to keep the walls relatively cool and also to prevent the coke-ash from overheating and lead to formation of large and hard masses of clinker. Such a generator was operated successfully for a considerable period with four different specimens of coke whose ash fusion temperatures (in a reducing atmosphere) ranged from 1200 to 1500° C.

The second part presents the results of investigations on the effect of the rate of blowing on the efficiency of the process. With the aid of general considerations from the thermal point of view of the reactions between air and carbon, and also of the conditions prevailing in the gas-generator, an equation has been developed to connect the efficiency of the process with the rate of blowing. Experimental studies with different rates of blowing were carried out with a view to ascertain the variation in composition of the blow-gas and also of the thermal losses incurred. The results obtained were in conformity with the theoretical considerations, *viz.*, the rate of blowing should be as high as practicable in order to reduce to a minimum the percentage of carbon monoxide and also to reduce thermal losses. It is at the same time necessary to regulate the period of blowing so as not to exceed the optimum temperature in the fuel-bed.

The effect of the size of coke on the efficiency of the process was studied systematically with reference to *effective surface*, *reactivity*, *time of contact*, composition of the gases obtained and thermal output. It was found that variations of the size of coke in the range 0·1″ to 3·0″ had no marked effect on the efficiency of the process.

The next point studied was the efficiency of the process when using different types of coke, *viz.*, vertical retort, horizontal retort and low-temperature coke. No significant variations were found, the process efficiencies being 72·4, 75·1 and 72·9 per cent. respectively.

The various sources of error which would tend to vitiate the results are examined in detail and presented in an appendix. These errors are small and are due to (*a*) hydrogen from sources other than the water-gas reaction, (*b*) nitrogen in the coke, (*c*) sulphur in the coke, (*d*) moisture in the air, and (*e*) dilution effects.

K. R. K.

Forthcoming Events.

4 Jan. 1936—The Second Indian Road Congress at Bangalore.

2—8 Jan. 1936—Indian Science Congress—23rd Annual Meeting, at the Daly College, and King Edward Hall, Indore.

2—4 Jan. 1936—
All India Obstetric and Gynaecological Congress, 1936 (will be held at Madras).

1954-35.—Printed at The Bangalore Press, Bangalore City, by T. Subramania Aiyar, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

The Passing Away of His Majesty King George V.

THE Royal Family of Great Britain and the whole Empire have suffered a grievous loss in the death of H. M. King George V, and the grief of the Queen and of the other members of the Royal Household must be inconsolable, but the thought that the whole nation irrespective of colour and creed stands by them in this hour of trial and calamity must assuage and sustain them in their sorrow.

We did not like the look of Reuter's news announcing King George's illness, when the people were warned that cardiac trouble had set in. His illness in 1928 must have worn out all the reserve of strength and any small distemper must naturally produce very grave effects.

His Majesty's rule extending over twenty-five years has witnessed great political vicissitudes, and the world went through unparalleled tribulations. During this momentous period of the world's history, the British Crown alone stood foursquare to all the winds that blew, and this is a remarkable testimony to the personal ascendency which His Majesty's simple life and great personal virtues had established in the hearts of his devoted and loyal subjects. His Majesty's rule was one for which few dynasties in Europe can furnish a parallel. During this eventful period science and letters progressed in a manner which few reigns have witnessed, and His Majesty's tender solicitude for the welfare and prosperity of the Great Commonwealth through scientific progress will be gratefully remembered by posterity. Edward VII was named The Peace-Maker, his illustrious son was a Peace-Lover whose efforts at promoting the peace of the world will form an illuminating chapter of the history of the times.

In the demise of His Majesty, King George V, the world has lost a great monarch, a devout Christian, and an estimable gentleman. We offer our respectful and sympathetic condolences to the bereaved Royal Family.

His Majesty King Edward VIII.

HIS Royal Highness the Prince of Wales has assumed the powers and duties of the King of Great Britain and the Dominions overseas and those of the Emperor of India. For the arduous responsibilities to which he has been suddenly summoned, His Majesty King Edward VIII has passed through a long period of intensive training, guided and inspired by his beloved father. Like the late King George V, the Prince of Wales was a naval officer, a student of the University of Oxford, and has widely travelled. But the greatest experience, which few of the recent British Monarchs possessed, fell to the lot of the new King. During the World War he served both in the Western front and Egypt, and witnessed what horrible troubles, miseries and sufferings a cataclysm of that magnitude implies. It will be remembered that in 1921 His Majesty visited India as Prince of Wales and his charming manners and urbanity won for him universal admiration, and most of all his great popularity amongst the student population was unrivalled.

H. M. King Edward VIII has an intimate knowledge of the labour problems and the demands of the industrial classes, and his recent and frequent tours in industrial areas have provided him with unique opportunities of studying them at first hand, and identifying himself with the poorer people. This is an indispensable equipment for every modern monarch for the success of his rule.

While we tender to His Majesty King Edward VIII our respectful sympathies for the great loss he has sustained, we offer our prayers to the Great Giver of all Good that He may shower His choicest blessings on the New King.

May His Rule be Long, Happy, Peaceful and Prosperous !

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National Intelligence.

SIR GIRIJA SHANKAR BAJPAI, presiding at the inaugural meeting of the Central Advisory Board of Education held in December 1935, expounded the aims and objects of the Board in these terms :

"The main function of the Board is to impart to Educational thoughts the impulse of progressive policy. It is because we aimed at ensuring fruition of advice into action, that we invited ministers in charge of Education in Provinces to sit on the Board. It is because we aimed at viewing the whole field of Education in one conspectus, that apart from Education Ministers and their Directors of Public Instruction, we have invited the Inter-University Board to send us three representatives. It is because we want our effort to be quickened and influenced by responsible political opinion that we have with us representatives of the Legislature."

Presumably these ambitious sentiments must have formed the concluding portion of an important public pronouncement by the Member-in-charge of Education on the general policy of the Government of India, and it is widely hoped that the large and representative body of eminent Educationists and Legislators who compose the Board might ensure the progressive realisation of the high purpose adumbrated at the inauguration ceremony. It must be remembered that the Central Board is not a statutory body, and is without the power of taking the initiative in the formulation of any educational project or policy. Its function, therefore, is restricted practically to advising the Government of India on problems referred to it, or to inviting information from the Provincial Governments and other organisations interested in educational matters, with a view to examine the material collected in order to frame a co-ordinated scheme of recommendations. Manifestly the success of the Board in either of these spheres must depend on two fundamental factors. The first pre-requisite is the time and energy which the members of the constituent committees can devote to the study and investigation of the special and general problems coming within their purview and having a specific bearing on the development of cognate subjects in the more progressive countries, and how far the members will bring the results of such study and research to bear on the discussion of the questions referred to the Board. The second factor relates to the ability and willingness of the Provincial Governments to adopt the recommendations of the

whose broad outlook is reflected in the enlightened and progressive policy of his State. The knowledge and experience which he has accumulated during his extensive foreign travels must be an asset to the administration and his solicitude for the improvement of village life in Baroda is marked by the recent grant of a crore of rupees for rural uplift. This signal act, coupled with the opening of a new science and technological institute will earn for His Highness the enduring love and gratitude of his loyal subjects, than which nothing can be more gratifying to an Indian Prince. It is the earnest prayer of the people of Baroda as well as of those of the rest of India that His Highness Sir Sayaji Rao may be spared for many years to rule his State and support proposals for a progressive constitution in British India.

Dr. S. S. Bhatnagar, D.Sc., O.B.E. and Sir Bryce C. Burt, Kt.

WE have great pleasure in felicitating Dr. S. S. Bhatnagar and Sir Bryce Burt on the distinctions bestowed upon them.

Dr. Bhatnagar is one of the most popular and distinguished professors of the Punjab University, where, as the Director of the University Chemical Laboratories, his researches have won for him a prominent place in the world of International Science. It will be remembered that in recognition of his valuable investigations of basic importance to the petroleum industry, Messrs. Steel Brothers Company Ltd. and Attock Oil Company recently placed at his disposal large sums of money for further researches on petroleum and allied subjects. In a spirit not unlike that of Faraday, Davy and Pasteur, Dr. Bhatnagar placed the large lump sum grant paid to him by Messrs. Miller and Ward as a personal gift, at the disposal of the University for inaugurating a department of Petroleum Research. Dr. Bhatnagar's latest book on "Physical Principles and Applications of Magneto-Chemistry," recently reviewed in our columns by Dr. Edmond C. Stoner, is a great contribution to the physical and mathematical aspects of the subject, which has won for the author wide appreciation. He has always been a steady and true friend of *Current Science* whose present position is due to his consistent and unstinting support.

Sir Bryce Burt first came into prominence by his distinguished work as Secretary to Central Cotton Committee, and the Government of India, in appreciation of it, appointed him Agricultural Expert to the Imperial Council of Agricultural Research. In this new sphere, he threw the weight of his knowledge and experience in advocating a liberal policy for the promotion of scientific research in all the departments of Agricultural Stations, the Universities and other research centres. On the retirement of Sir T. Vijayaraghavacharya, Sir Bryce Burt became the Vice-President of the Council and this appointment testifies the wide popularity which he enjoys among his colleagues and the esteem and confidence which the Government of India have in his sobriety of judgment and technical knowledge. *Current Science* and *Agricultural Science* owe much to him.

Application of Statistics to Field Technique in Agriculture.

By Rao Bahadur M. Vaidyanathan, M.A., L.T.,
Statistician, Imperial Council of Agricultural Research, New Delhi.

Introduction.

APPLICATION of statistics to field technique in agriculture is now assuming an importance and a usefulness which can be compared only to the utility of a tool to a mechanic or of an instrument to a surgeon. Statistics is now an indispensable dissector for an agricultural experimenter to judge the results of his experiments, and the modern agronomist cannot now for a moment dispense with the applications of modern statistical theories for properly designing his experiments and for a valid interpretation of his results. On these aspects of field technique a co-ordinated research is necessary as in every other science, and it seems doubly so in the case of statistics applied to agriculture owing to its varied applications and to the varying conditions under which it is to be applied. The American Society of Agronomy is doing its best to co-ordinate the statistical researches as applied to agriculture, and the Agricultural Research Council in England has been emphasising the need for sound statistical treatments in connection with field experiments. The Imperial Council of Agricultural Research in India is not slow to take to modern statistical ideas, and has been pleading for a correct statistical technique in the case of field experiments in the Provinces and Indian States.

It should, however, be mentioned that statistics is only a means to an end, and that its application to field technique is intended merely to provide standards for comparisons of results from experiments conducted under known conditions. It is in no way intended to create an art by itself and in no way meant to discourage the experimenter from utilising his full knowledge to his best advantage. Even experiments which had not been designed from the point of view of modern statistical ideas could be studied and interpreted, but it should be emphasised that a proper design for an experiment with a view to a valid interpretation of results, would go a great way in strengthening the hands of the experimentalist, and giving him a courage and a conviction in "disentangling the diverse factors that contribute to a joint result". This is just what happens in the study of results of an agricultural experiment, where a number of variations such as soil heterogeneity, varietal effects and manurial effects, operate jointly to produce a single result of, what is known, as the *plot yield*. Under old ideas, a *high* percentage difference in plot yields, say, of two varieties under trial, is a sufficient guarantee that one variety is superior to another, but according to modern ideas while *high* and *low* are purely relative terms, the *significance* of the difference should be based upon a knowledge how far *chance* had operated in bringing out that difference. If the *chance error* is high, even a high difference—say 30 to 40 per cent. difference—may not be *significant*.* This is the experience met with in some of the recent results in agricultural experiments in India, where it was found that a high percentage difference of even 30 per cent. between treatments was found not *significant*. Thus a successful experimenter should try to bring down his random error as low as possible; so that even *small* differences between different factors at work—say differences in yield of different varieties—may on the basis of this error be *significant*. But even more important is the *validity of estimates* of error, which can be secured only by a *suitable design*. The validity of estimate of error depends partly upon whether estimates of other variations such as soil heterogeneity in an agricultural experiment are properly eliminated from our accounts, and partly upon whether our sample of plot yields is a *random* sample of population. A proper design for an experiment is thus the only panacea for ensuring a valid interpretation of results. We have now reached a stage in the progress of field technique, when we could plan even a complex experiment where a number of interrelated factors can be simultaneously studied, and significance deduced.

Principles of Modern Experimental Design.

This takes us to the *three* broad criteria for a satisfactory experimental design, which are now more or less accepted. *Firstly*, as seen already, the error of the experiment

* The exact connotation of *significance* is explained in the subsequent paras.

should be as low as possible giving a maximum precision for the experiment. This can be secured only by a sufficient number of replications. The need for replications in a field trial is now easily recognised, as the experimenter knows by experience that this is the only way of eliminating from his comparisons the effects of soil variation obtaining in the field. The *second* condition for a satisfactory field lay-out is that the error as estimated should be a *valid* estimate. Old plans of lay-out and methods adopted for estimating the error did not aim at separating the portions of the differences due to several causes, and hence led to aggregates which were of only limited application. For example, Mercer and Hall's method of basing the error of an experiment upon plot variations of individual treatments did not discriminate between the variations due to several factors; so also Engledow and Yule's which did not take into account the soil variation. Modern methods of field experimentation are intended to remedy this defect. The *validity of the estimate* for error can, however, be secured by a sufficient number of replications, provided the plots represent random samples of the experimental area. As this condition is generally not satisfied, what is known as *randomisation* is now introduced in all field experiments [by which plots in each block (or row and column) are randomised with respect to treatments under trial]. This ensures, in the language of Fisher, that "the differences utilised in the estimation of error (by which differences between unlike plots are judged) are properly representative of the other errors which produce the actual errors of the experiment". So long as we recognise that a correct interpretation of results depends upon valid estimates for error, the best way for securing such a valid estimate seems to be only by arranging the plots at *random*. Any systematic arrangement of plots cannot secure an unbiassed estimate for error and the old idea of having unlike plots as close as possible deprives us of a useful method for deriving a valid estimate for error. The arguments against *randomisation* sometimes advanced by agricultural workers are discussed in the next para. The third criterion is that the design should be such that all soil differences could be eliminated from the comparisons to be made and equally well from the estimates of error which form the very basis for judging "significance". It is found from experience that increasing the replications beyond a certain limit cannot bring on an additional precision for the experiment, which, therefore, limits the number of replications. To secure the object of eliminating soil differences, replication cannot therefore be a sole remedy, and the modern plan is to limit the area of the experimental field and to demarcate it into "blocks", or "rows and columns"; thus securing "localisation of control", by which it is possible to eliminate soil differences by proper field arrangement, and to increase the precision of the experiment, without unduly increasing the number of replications.

These three broad criteria for a proper design for a field experiment have led to three broad concepts:—*Replication*, *Randomisation* and *Localisation of Control*. Their objects are, briefly mentioned, to secure a valid estimate of error by means of a suitable design and an improved precision for the experiment by taking into account all possible variations such as soil heterogeneity and varietal effects, and by eliminating them from our calculations of error.

RANDOMISATION—POSSIBLE OBJECTIONS AND HOW THEY ARE MET.

While *randomisation* seems thus theoretically a necessity, there has been an acute controversy among the agricultural experimenters in India and elsewhere with regard to the utility of the method. It would be worthwhile at this stage to examine the objections raised against the method, and see how they could be met. A common objection raised is that the randomised method does not show on the field to the eye of an observer the relative differences between treatments: thus while an arrangement A B C, A B C, in several blocks systematically arranged might show the relative differences of treatments, an arrangement like A B C, A C B, C A B...... could not show at a glance these differences. But this is no argument against *randomisation*, and besides there is a confusion in this argument between a *field experiment* and a *demonstration* plot. While in the latter, the results should be demonstrated to the layman to appeal to his eyes, the former is essentially the domain of an experimentalist—for him to ensure the results and to satisfy, before they can be tried on a large field scale for confirmation. There could be no mistaking these two, and it is wrong to presume that one is a substitute for another.

The second argument usually advanced is that mistakes are easily committed in a randomised arrangement owing to untrained labour, which are avoided in a systematic arrangement. This is again no argument at all and the general experience is that Indian labour, if properly trained even for a short period of one season, picks up the details of even complicated plot arrangements so quickly, that it is unfair to advance this point as an argument against randomisation. The third argument against randomisation is that in several of the systematic arrangements recently adopted in the Indian farms, the standard error is found to be very low—even at 3 per cent.—and that therefore there is no need for changing the plan. But then there is no guarantee that this small error is a *valid estimate* of error, which, as we have seen, is a fundamental condition for a valid interpretation of results. Experience has shown that correlations between plots such as existing between high-yielding and low-yielding plots are often marked, and that they vitiate the results sometimes very badly. Thus any systematic arrangement of treatments in a field experiment seems to have no justification whatsoever. It is therefore seen that while the arguments usually advanced against randomisation are mainly from the point of view of practical agricultural considerations, the theoretical aspects of the problem have not entered into them. *Randomisation* in a field experiment seems therefore a necessity and it seems irrevocable till we can find a substitute for it.

PRINCIPLES OF ANALYSES OF VARIANCE AND CO-VARIANCE.

The whole statistical problem connected with the lay-out of a field experiment thus resolves into the possibility of analysis of total variation of plot-yields into those due to the component factors, and the use to which such an analysis can be put for testing the significance. Such a possibility presupposes a suitable design for the experiment—a design adapted to proper calculations and valid separations of those variations. In a randomised block arrangement, for example, each plot-yield may be regarded as in part due to the particular block in which it is situated, as in part due to the particular treatment and as in part due to a residue on account of what is called *error*.

The method of analysis of total variation into component items is effected by what is now generally known as Fisher's "Analysis of Variance". The method of analysis of variance has become classic in the modern theory of statistics, and it is now freely applied not only to agricultural experiments but to economic and biological studies where a number of factors operate to produce a joint result.

The principle of the analysis of variance as applied to data where only two factors cause variation is brought out by the single algebraic identity :—

$$\sum_{1}^{Kn} (x-\bar{x})^2 = K\Sigma(\bar{x}_p - \bar{x})^2 + \sum_{1}^{Kn}(x - \bar{x}_p)^2.$$

The formula exemplifies the simple truth that if Kn observations be split up into n groups with K individuals in each group, then the total variation or what is known as the 'total sum of squares' can be split up into (1) the 'sum of squares' due to deviations of the *means* of the groups from the general mean (multiplied by the number in each group), and (2) 'sum of squares' due to variations of the individuals from the means of groups to which they belong. These two causes of variation are known as due to 'between classes' and 'within classes'. The two causes of variation are *independent*, and any individual x in the pth group for example may be expressed as $x = \bar{x}_p + \bar{x} +$ error, the error portion being that left over after assuming the effects of the two independent causes. The relative importance of the two variances† measures the correlation, if any, in the sample; if the variances are equal, the correlation is 0, and if they are not we may express the relationship in terms of r. If the variance of 'between classes' is larger than that due to 'within classes', then the intra-class correlation is +ve and if smaller it is −ve. Apart from finding the existence of any correlation or otherwise in the sample the analysis of the total variation into component factors, as we shall see in the subsequent para, provides us with a test of significance for homogeneity or otherwise of the sample, which is by far the most important use to which 'the analysis of variance' has been put.

Equation (1) can now be extended to the case of three items of variation producing a joint result. Thus in the case when Kn individuals are split up into n groups with

† Variance is 'the sum of squares' divided by the appropriate number of degrees of freedom or independent estimates.

K individuals in each group and with the restriction say that the variation of the rth individuals in the several groups is also to be considered, then the identity becomes :—

$$\sum_{1}^{Kn} (x - \bar{x})^2 = K\Sigma(\bar{x}_p - \bar{x})^2 + n\Sigma(\bar{x}_r - \bar{x})^2 + \Sigma(x - \bar{x}_p - \bar{x}_r + \bar{x})^2.$$

This corresponds to the case of a randomised block arrangement with n blocks, and K plots in each block corresponding to K treatments under trial. The last item corresponds to "error" or "interaction" between the first two items of variations. The whole analysis is easily seen to be a process of fitting constants so that the error variance is least ; that is to say, if the observed plot yield y_{uv} (*i.e.*, of uth block and vth treatment) is considered to be the sum of different effects such that $y_{uv} = K + t_u + b_v +$ error then by summing this for all the plots and by applying the method of least squares for minimising the error the best values for the constants will be :—

K = general mean of all plot-yields.
t_u = the treatment mean.
b_v = the block mean.

The principle of "analysis of variance" can now be extended to any number of simultaneous classifications of different sets of groups or classes. Now defining an n-fold classification as one containing n classes or groups into which a sample can be analysed, a randomised block arrangement, say with 4 treatments, is then a *double four-fold classification* (*double*, because only two items of variance *blocks* and *treatments* enter into calculations) ; similarly a 4×4 Latin Square will be *a triple four-fold classification*, and so on. It may be of interest to note that in the types of designs which we are dealing with (*i.e.*, orthogonal‡ designs), as one set of effects does not alter the other sets, the constants may be fitted in *simultaneously* or *one after another*, and the sum of squares for the different effects will be the same by either process. Again so long as the design is *orthogonal*, that is to say, so long as the different items of variance can be estimated separately and directly, the total sum of squares will be equal to the total of the sums of squares contributed by individual items. Thus in a Latin Square arrangement the variances of the different items—rows, columns and treatments—may be separately calculated and their sums of squares totalled up will be equal to the total sum of squares. The calculation of the analysis of variance in cases of orthogonal designs has been simplified very much recently, and the easiest method will be to calculate for each item of variance—say block variance in a randomised block arrangement—the sum of the squares of the totals of several blocks divided by the number of plots in each block and to subtract the correction T^2/n (where T is the total of the plot-yields and n the number of plots) ; and the correction will be the same for all items of variance.

Just as the variation of a single variable x could be separated into several items such as those due to "between classes" and "within classes", similarly if pairs of observation of two correlated variables x and y occur in groups, the co-variation of x and y could be separated into different items. Thus in an agricultural field experiment involving blocks and treatments, the plot-yields in any two years may be correlated, and the co-variance may be analysed into items (1) blocks, (2) treatments and (3) error. The co-variation of x and y is of course measured in terms of *mean product*, just as variation is measured in terms of *mean square* ; b, the regression co-efficient, is the ratio of the co-variance§ of x and y to the variance of x. To an agricultural experimenter, the chief interest in the "co-variance" lies in its application to the correction of plot-yields in a set of plots in one year on the basis of yields in the same set in the previous year or years. In a field experiment, a knowledge of preliminary yields may help to know *firstly* how the yields in the experimental year are affected in relation to the preliminary yields and *secondly*—which seems more important—how the standard error of the experiment changes. Assuming a linear regression of y on x, where x is the preliminary yield and y the experimental yield, any correction to be made in the yields of any two plots treated alike in the experimental year, should obviously be based on the difference in yields of those plots during the preliminary period ; and assuming a linear regression $y = bx$, b, the co-efficient of regression is the ratio of "co-variance of error in xy

‡ Explanat[illegible] of 'orthogonal designs' is given in this [illegible]eras.

§ The *co-variance* is the mean product of x and y measured from their means.

analysis" to the "variance of error" in the analysis of preliminary yields. It is interesting to note that the analysis of variance of x and y, and the analysis of co-variance of x and y follow the same procedure in the matter of computation and that from these tables "b" is easily computated, and hence the sum of squares of the adjusted yields from the formula :—
$(y - bx)^2 = y^2 - 2bxy + b^2x^2$. The adjusted yield itself is then $y - b\ (x - \bar{x})$.

In experiments on perennial crops (such as 'tea'), a plan of lay-out is now adopted of what is known as 'equalisation of plot-yields,' by which sets of plots in the several blocks are so chosen that the sum total of yields in the same set during the preliminary period is the same. This method of lay-out combined with an assumption of regression between the preliminary and the experimental yields has given excellent results in the reduction of the standard error, and in the effective comparisons between treatments. But in the case of a few experiments on perennial crops conducted in India the co-variance between preliminary and experimental yields has not given any increased precision for the experiment. It should, however, be pointed out that where treatments themselves have produced differential effects during the preliminary period, the method of co-variance (or the assumption of regression of *error* between the plot-yields during the preliminary and the experimental periods) fails to give a correct perspective for an altered *precision* for the experiment. This is a very important point to be borne in mind in the application of the method for judging the improved precision of experiments on the basis of preliminary trials. But where the preliminary trial is an unbiassed uniformity trial (*i.e.*, subject to the same or no treatment), then the method can be freely applied.

OTHER APPLICATIONS OF THE METHOD OF CO-VARIANCE.

It is possible to apply the method of co-variance to other cases arising in agricultural experiments, where accidental factors come into play such as uneven germination and insect pest, the effects of which cannot be measured. In such cases, we might, for example, correlate the number of plants with the eventual yields, and thus correct for the differences in the plant number in different plots by the method of co-variance. The germination count in different plots will thus be a very important guide in judging the effects of such accidental factors. Another use to which the method of co-variance can be usefully employed in an agricultural experiment is to know what exactly the factor or factors connected with the crop that influence the eventual yields. This will be of great help to understand the different stages of plant growth leading to the yield as the effect of treatments. Thus in the case of cotton, if boll-count should be the deciding factor, we might assume a regression of the yield on boll-count; or if the yield should depend upon the boll-size that will be the factor to be correlated. As another example, in the case of rice or wheat, we know 'tillering' is a very important factor influencing the yield, and we might usefully study by the method of co-variance its effects, at several stages of plant growth, on the yield. Thus the method of 'co-variance' helps to study 'the mechanism' by which the treatments produce their eventual effects. Such intensive studies have been undertaken in some of the Indian farms but the results need to be collated in a broader perspective.

CHOICE OF PROPER STATISTICS.

Once that the variations can be analysed into their component factors on certain valid assumptions, the problem turns out to be one of the study of '*significance*'. Stripped of all technical language the question is :—" If with respect to a *sample* the variance of one is larger than that due to another, can we say that the variation of the first is *significantly* higher than that of the second?" In an agricultural experiment to judge, say, the comparative performances of varieties, what is needed is firstly whether the variance due to varieties is *significantly* larger than that due to error, so that we can say with confidence that our experiment is a success; and secondly whether on the basis of 'error' one variety is *significantly* superior to another. Both these tests depend upon the exact meaning and implication we attach to the expression 'significance'.

The connotation of what is termed as 'significance' or 'significant difference' obviously depends upon what we can expect in the *population* of which our data are a sample. From the *statistic* or *statistics* calculated from our *sample*, can we say that it is a random sample of the original

population? In other words, a sample of size n is observed, and the problem is whether we could say that the sample is a random sample of the original population. In case the character of the population is known, inferences with regard to the sample are expressed in terms of mathematical probability, but where we should infer from the sample only, the problem is firstly one of estimation of the population and then the probability of occurrence of the sample, which, in the language of Fisher, is a function of the unknown parameters of the population which we are trying to evaluate. Fisher would call this function *likelihood*, and his solution by "the method of maximum likelihood" (explained later) would provide *efficient statistics*. In an agricultural experiment n cannot be large and this adds to the complexity of the problem. The main difficulty, however, is to specify the population in terms of the sample. If the character of the population *can* be assumed,—such an assumption is not always valid,—then it is easier for us to verify by mathematical processes whether the sample is a random sample. The *specification* of the population is by means of parameters based upon *statistic* or *statistics* which are functions of the variables. Thus we may specify a population by $y = a + bx + cx^2$ and so on, where a, b, c,........ depend upon the statistics to be calculated from the observations. The choice of the mathematical expression itself is largely intuitive, and χ^2 test (explained later) will show how far the assumption is justified.

In the problem of estimation, however, we shall have to assume the form of the curve for the population with one or more unknown parameters. Now then with the *sample* values, the first requirement is the choice of the statistics for an estimation of the parametric functions of the population, and the second is to calculate the *chance* for the sample *being a random sample* of the population. While the first requirement involves a suitable choice of the statistic or statistics,—for any number of such statistics will be available for estimating the unknown parameters of the population,—the second requirement is answered by a study of the mathematical law of distribution of the statistic or the parameter evolved out of it, as it varies from sample to sample of a constant size. n, the size of the sample, thus becomes a primary consideration both in the choice of the statistic or statistics and in the evaluation of distributions. Fisher classifies all *statistics* into those *consistent and inconsistent, efficient and inefficient* and *sufficient and insufficient.* In estimating parameters of the population, we could have innumerable statistics from which to estimate them, but the conditions for a proper statistic are:– *firstly*, that it should tend to a fixed value as the size of the sample is continuously increased, or in other words, that it should centre round a fixed *value* with errors or deviations from it distributed in a normal curve; *secondly*, the particular statistic selected should give a very low variance in *large* samples, *i.e.*, lower than those of other statistics which we could possibly think of, and *thirdly*, the statistic selected should be examined for its sufficiency, that is, whether it can supply all information regarding the sample, in which case, even if it does not give a low variance, there is no need for the calculation of other statistics. The first criterion secures *consistency*, the second *efficiency* and the third *sufficiency*. Taking the Arithmetic mean of a sample as an example of the statistic from which to calculate the parameters of the population, we know that it is *consistent*, since in large samples it is distributed in a normal law. But its *efficiency* will depend upon whether other statistics are *not* available also normally distributed as n is increased, but giving a *lower variance* for the purpose of estimating the parameter of the population. Now since the variance falls off inversely with n, the condition for efficiency is that the limiting value of $\frac{1}{nV} \leqslant i$, where i is independent of the estimation used. Thus if the original curve be *normal*, the Arithmetic *mean* is consistent and efficient in estimating a parameter of the curve, but its efficiency is lowered when it is used to estimate say an exponential curve, where other statistics define the parameter of the curve more accurately. Again in *small* samples, the *Arithmetic mean* is sufficient to give complete information of the sample, and though it may *not* be efficient in the sense explained above, it serves the purpose so far as it completely summarises all possible and available information from the sample.

Thus we shall have to choose from a number of *consistent efficient* statistics the most suitable one to deduce the best estimates of the parameters of the population. Fisher's method of maximum likelihood helps a

solution of the problem. If θ be the unknown parameter of the population, the method consists in multiplying the logarithm of the expected frequency in each class by the observed number, and summing for all the classes; and solving for θ such that the sum is a maximum. As a simple example, if a, b be observed numbers in two classes so that $a + b = n$, with probabilities of their occurrences say $f(\theta)$ and $1-f(\theta)$ respectively, then the maximum likelihood solution will give θ for which

$$a \log f(\theta) + b \log \{1-f(\theta)\} \text{ is a maximum.}$$

The positive solution for θ secures a statistic with a low variance.

χ^2, t, z TESTS OF SIGNIFICANCE.

From what has been said, what is needed with respect to a sample of n observations (n not being large) is the deduction of valid tests of *significance*, to know *firstly* whether the sample is a random sample of a homogeneous population, and *secondly* whether the *means* calculated from the sub-samples differ significantly on the basis of analysis of variance. Dealing with 'variance', it is probably legitimate to assume that the original population is *normal*, in which case the scheme of analysis of variance explained already, combined with a knowledge of distributions of the statistic or statistics in random samples helps to arrive at proper tests of significance. In the case of an agricultural experiment, the procedure of analysis into variances due to blocks, treatments and error (or in the case of complex experiments including all interactions of higher orders) helps an understanding of how best the test could be applied.

There are three such tests now in vogue which are easily explained. What is known as χ^2* test (or test of 'goodness of fit') given by Karl Pearson in 1900 is intended to test agreement *between observation* and *hypothesis* where the variates are normally distributed and mutually correlated. It is based upon the distribution:

$$df = K \ \chi^{n-1} e^{-\frac{1}{2}\chi^2} d\chi.$$

'Student' showed in 1908 that the same law holds good in the case of the mean square of a random sample drawn from a normal population. χ^2 test has however been found not effective when either the method of fitting is inefficient, or when negligible values are included in the cells of the sample. But generally speaking, the method has been found to be one of the most powerful tools in modern statistics, which ensures the very first step in all biological studies for verifying observation with any assumed hypothesis. But there is some misunderstanding with regard to the full utility of χ^2 test which seems to have arisen from the confusion sometimes caused in the two independent statements:—

(1) A sample does not differ *significantly* from an assumed population $f(x)$.

(2) A sample is most *likely* to be a *sample* of a population $f(x)$.

While (1) can be tested by χ^2 method, it does *not* however follow from (1) that (2) is true. There might be any number of populations of which the given sample could have been extracted, all satisfying the χ^2 test at the same or particular levels of significance, but only those giving low variances are to be preferred. In other words, χ^2 method is useful only to this extent, that it can safely be employed to test whether the given observations agree with an assumed law or not, but not to test the reverse that the original population should be the one assumed. Thus, for example, it can be employed to test, in genetics, whether there is agreement between observations and Mendelian class frequencies, or in biology *independence* in a four-fold or an n-fold classification assuming the marginal totals to be true. But in either case, unless fresh evidence is adduced, the complete identity of the sample cannot be assured.

't' and 'z' Tests.—The two other tests 't' and 'z' have now become very popular with the agricultural experimenter. In fact, no experimenter now-a-days takes the trouble of enquiring whether conditions necessary for the applications of these tests are fully satisfied; but it is however found that even when those conditions are *not* completely satisfied, they can safely be employed for testing 'significance'. What is known as 't' test is to test whether the observed 't' from a sample, *i.e.*, $\left(\frac{\text{mean}}{\text{S. E. of mean}}\right)$ follows the distribution of 't' from all possible random samples of size n (for varying values of n). 'Student' gave his distribution of 't' in 1908, in his classical paper 'the probable error of the mean'. The utility of Student's distribution is now seen in almost every kind of problem where the significance of any statistic in terms of its standard error

* $\chi^2 = \Sigma x^2/m$ where $m+x$ is the number observed, and m the expected.

has to be tested. 't' tables have been constructed (*e.g.*, Fisher's tables) based upon theoretical distributions, giving the *probability* or *odds* for or against deviations from the observed 't' occurring due to chance from which the significance could be judged. The theoretical distribution of 't', as in the case of those of other statistics, is based on the assumption that the original population is normally distributed, and that a random sample of size n is drawn from it so that the chance of $(x_1, x_2 \cdot\cdot, x_n)$ in the interval $(dx_1, dx_2 \cdot\cdot, dx_n)$ is given by :—

$$df = \mathrm{K}e^{-\frac{1}{2}\sum_1^n \left(\frac{x_r - x_m}{\sigma}\right)^2} dx_1, dx_2 \cdot\cdot, dx_n$$

(where m and σ relate to the population). By a suitable transformation, the distribution of s^2 {*i.e.*, that of 'the variance' of the sample calculated from the expression $\frac{1}{n-1}\Sigma\left(x_\gamma - \bar{x}\right)^2$ is deduced, and similarly that of 't'. We have after transformation :—

$$df = K'e^{\frac{-n(\bar{x}-m)^2}{2\sigma^2}} e^{\frac{-(n-1)s^2}{2\sigma^2}} s^{n-2}\, d\bar{x}ds$$

showing that $\bar{x}$ and s are independent, so that the distribution of s is :—

$$df = K'' \left(\frac{S}{\sigma}\right)^{n-2} e^{-(n-1)s^2/2\sigma^2} \frac{ds}{\sigma}$$

It can be shown that the mean value of s^2 from all possible samples is σ^2 showing that s is an unbiassed estimate for σ and that by the method of maximum-likelihood the best estimate for σ is s (*i.e.*, giving the smallest sampling variance). But be it noted that s^2 is calculated with $(n - 1)$ as divisor in place of n to give an unbiassed estimate for σ^2, which is necessary for the simple reason that we are estimating both the mean and the standard error from the same sample, both deviating from their true values.

What is known as Fisher's 'Z' test is more comprehensive (t test, as we shall see, is only a special case of 'Z' test) and is intended to test whether the given sample is a random sample of a normal population. Fisher's 'Analysis of Variance' combined with the 'Z' test are now a landmark in the theory and practice of statistics applied to agricultural field technique. The principle of 'Z' test is this :—When the total sum of squares is split up into different sums due to a number of items, the variance of each item (*i.e.*, the sum of squares divided by the appropriate degrees of freedom) should be an *unbiassed* estimate of σ^2 of the population. If s_1 and s_2 are two such estimates of samples of a normal population derived respectively from n_1 and n_2 degrees of freedom, the distribution of

$$Z(= \tfrac{1}{2}\log_e s_1/s_2)$$

for varying values of n_1 and n_2 is an efficient statistic, and should help in judging whether our sample is a random sample of a normal population. What are known as 'Z' tables, at 5%* and 1%* levels have been constructed by Fisher on the basis of the distribution of Z, for varying n_1 and n_2. The distribution of 'Z' is based upon the distribution of s_1 and s_2, and is given by :—

$$df = \frac{2n_1^{\frac{n_1}{2}} n_2^{\frac{n_2}{2}} \Gamma\left(\frac{n_1+n_2}{2}\right)}{\Gamma\left(\frac{n_1}{2}\right)\Gamma\left(\frac{n_2}{2}\right)} \times \frac{e^{n_1 z}dz}{(n_1 e^{2z} + n_2)^{\frac{n_1+n_2}{2}}}$$

s_1 and s_2 should not appreciably differ if they relate to a random sample of a homogeneous normal population, but if they do, it will be indicated by a low value of P, and the sample cannot then be a random one. It may be pointed out that the 't' test is only a special case of 'Z' test, since for $n_1 = 1$ and $n_2 = n$, $Z = \frac{1}{2}\log_e t^2 = \log_e t$. Thus if we take any value of 't' from 't' table for n, $\log_e t$ will be the same as 'Z' from 'Z' table for $n_1 = 1$, and $n_2 = n$.

In an agricultural experiment where the total variance is split up into variances, say, due to blocks, treatments, and error, denoted respectively by s_1, s_2 and s_3, then if $\frac{1}{2}\log_e s_2/s_3$ is greater than 'Z' from the tables, at any level significance, (5% or 1% level is by convention the usual level taken), we infer that the soil is heterogeneous; if $\frac{1}{2}\log_e s_2/s_3$ is similarly greater than the theoretical 'Z', the general effect of treatments is significant. In either case, however, the sample cannot be a random sample from a homogeneous normal population. The success or failure of an experiment will depend upon the later criterion, *i.e.*, whether the variance due to treatments is significantly greater than that due to 'error'; if it is not greater, then the 'error' preponderates and no inference is possible from the experiment. From the 'Z' test we

* 5 per cent. level=chance 1 in 20; 1 per cent. level=chance 1 in 100.

proceed to compare the treatment-means by 't' test on the basis of the residual error. If s be the standard deviation per plot and n the number of replications, $s/\sqrt{n}$ is the standard error of treatment-mean and $\sqrt{2}s/\sqrt{n}$ is the standard error of difference of two means; this multiplied by 't' from the tables (at 5% or 1% level of significance) will be the critical difference between the means; if the difference between any two treatment-means exceeds this critical difference the difference between treatments is taken to be *significant*.

Doubts have been raised off and on, both by statisticians and agronomists, firstly about the validity of 'Z' test on the score that the original distribution may or may not be normal for which in any case there is no evidence; and secondly, whether, after establishing that the sample is *not* a random sample from a homogeneous normal population by the 'Z' test, we are justified in accepting the estimates of variances as *valid* estimates. The first objection is equally applicable to distributions of other statistics also, such as s and t, and our justification is that an assumption of a homogeneous normal distribution for the original population is sufficiently valid for all practical purposes, and that any departure from normality does not sufficiently impress upon our final form. With regard to the second point, it can be easily proved that the validity of the estimate for 'error' is *not* affected by any change in our hypothesis and that only the variances due to other factors are affected. But though this may be true, the adequacy of 'Z' and 't' tests is still there, and it is not in any way vitiated by the change in variances under 'blocks' or 'treatments.' It should be remembered that our analysis of variance procedure is not intended so much to *estimate* the variances, as to provide *adequate tests of significance.*

EXPERIMENTAL DESIGNS—MISSING PLOT TECHNIQUE.

Enough has been said to show that for a valid interpretation of results in a field trial a suitable design (combined with a proper method of analysis of the results) is absolutely and fundamentally necessary. Such designs may be classified into *orthogonal* and *non-orthogonal.* Examples of orthogonal types are the usual randomised block method and the Latin Square arrangement of plots where it is possible to estimate *separately* and *directly* the different items of variance; in such cases, the *mean* yield of all the plots receiving the same treatment, or the *mean* yield of block totals provides the best estimate for the treatment or block effects. It is thus possible in a randomised block arrangement to estimate from the treatment means the treatment effects, from the block means the block effects and so on, without either of them affecting the rest in the eventual calculations. In any such design, increase in fertility in one block affects all treatments *alike*, and conversely the effect of a particular treatment influences the yields of all the blocks; blocks and treatments are thus mutually orthogonal. Fisher's procedure of Analysis of Variance is particularly adapted to orthogonal types of experiments, though the procedure of analysis of variance in all cases is only an application of fitting constants which is the general method of analysis in dealing with all designs including even non-orthogonal types. Cases of non-orthogonal types are however unavoidable even in experiments of what are known as *simple* types, *i.e.*, with only one set of factors under trial—say a few varieties to be tested. It is, for example, quite an ordinary occurrence to see a few experimental plots spoiled by accident such as insect pest and flood so that the intrinsic yields of these plots are not known, or again for lack of knowledge of the initial fertility of the plots to get differences in treatment yields very much pronounced. In a recent case of an experiment which came to the notice of the author, not only was the design faulty as both the plot size and block size were abnormal with an insufficient number of replications, but also some plots were found to give abnormal yields. The orthogonality of the design in such cases is so much disturbed, that either the whole experiment should be discarded, or mathematical devices employed to correct for the abnormalities. In such cases the usual method of analysis of variance should be modified to suit each particular case.

In case where only one or two plots are 'missing', the usual procedure of the Analysis of Variance easily helps to calculate the best values for the missing plots. Thus if x, y be the 'missing' values, we have only to calculate algebraically, 'the error variance' by the usual method of analysis (which will involve x and y), and to minimise the variance by differentiating it with respect to x and y, by equating the two differentiated

functions to zero, and by solving the equations for x and y to obtain the missing values. The process is the same as fitting constants to give a minimum variance to 'error'. The princple may be extended to the case of any number of missing plots, but it is *not* advisable to carry the process to more than 2 or 3 missing plots. There are, however, two points to be noted in such an analysis :—Firstly, the number of degrees of freedom for 'error' will be the usual number less the number of 'missing' plots, for the simple reason that values of constants have been derived from the known plots only. Secondly, 'the treatment variance' obtained after substituting the missing values is bound to be less—though only slightly ordinarily—than usual, and thus the application of any missing plot formula will show an exaggerated accuracy for the treatment averages. In such cases, a correction has to be applied which will depend upon the analysis of the original values, with 'the error' portion deduced from the calculated values.

COMPLEX EXPERIMENTS—CONFOUNDING.

It is the glory of the recent developments of statistics, that modern field technique aims at testing any number of inter-related factors simultaneously. Thus in the same experiment of a cultivation trial, sowing date, spacing of plants and age of seedling may all be tried together, instead of having three separate experiments with one for each of the factors. This would not only economise time, space, and energy, but would also aim at the truth more accurately than what an experiment with only a single factor could do. In fact, where a number of deliberate factors influence a result, such as sowing, spacing and age of seedling would with respect to the yield, it seems futile to try each of the factors separately. The only satisfactory method is a complex layout involving all the factors with a suitable planning. Such complex experiments may always be *orthogonal*, that is, if for example 3 sowing dates, 4 spacings and 3 ages of seedling should be tested, $3 \times 4 \times 3 = 36$ treatments may all be completely *randomised* in the same block, with say 4 or 5 replications. This is an ideal method for such trials, and is analogous to a simple experiment which we have dealt with already, except for a change in the items to be considered in the eventual analysis of variance; in such cases not only should we consider the main effects but also the interactions between the several factors which may in some cases be appreciable. Thus, in the particular example which we are considering, the different items of variance will be (1) sowing dates, (2) spacings, (3) ages, (4) to (6) interaction between sowing and spacing, that between spacing and age and so on, (7) second order interaction between all these factors, and (8) error. The method of calculation of the several variances is the usual procedure and for arithmetical calculations for working out the interactions, say that due to sowing and spacing involving 12 ultimate treatments, the variance of these 12 treatments *minus* that due to sowing *minus* that due to spacing will give the interaction required. This procedure is, as noted already, the same as fitting constants to represent the several effects and deducing them by the method of least squares.

But difficulties in the conduct of orthogonal complex experiments are experienced to be :—(1) the agricultural difficulties in the arrangement of diverse factors in a single lay-out; for example, where differential irrigation is involved, it brings on lateral seepage from plot to plot ; (2) the huge extent of land needed for the experiment, which the experimenter usually finds difficult to secure. In either case, the remedy is found to be to 'confound' the effects by a deliberate plan, and to alter suitably the usual methods of analysis; such a process of 'confounding' will not only economise labour and space but will provide, as Fisher has shown, very efficient tests of significance.

We will consider here two simple methods of 'confounding' which may be usefully adopted by the agricultural experimenter in India. Take the case of an experiment involving two treatments, represented by types A and B, with n_1 and n_2 numbers respectively in each class, so that there are $n_1 \times n_2$ ultimate treatments. A type of layout which meets the first difficulty is to have n_1 sub-blocks in each block, and to have n_2 plots in each sub-block ; the n_1, A-treatments, and n_2 B-treatments corresponding to each of n_1 A-treatments, being separately randomised. This is a case of 'confounding' the main effects with a *partial* randomisation only, and the Analysis of Variance should separate the error of the A-treatments from that of B-treatments as shown below ;—

A–TREATMENTS.

	Degrees of Freedom
Blocks ..	$(K - 1)$
A–treatments ..	$n_1 - 1$
Error (A) ..	$Kn_1\text{-}K\text{-}n_{1+1}$
Total :—	$Kn_1 - 1$

B–TREATMENTS.

	Degrees of Freedom
From Blocks and A–treatments ..	$Kn_1 - 1$
From B–treatments ..	$n_2 - 1$
Interaction between A & B	$(n_1 - 1)(n_2 - 1)$
Error (B) ..	$(K-1)(n_1n_2 - n_1)$
Grand Total :—	$Kn_1n_2 - 1$

The defect in this method of lay-out however is that the two errors A and B cannot be consistent in the sense, that while A-error is derived from fairly big plots, B-error is deduced from contiguously small-sized plots which would therefore be small. The efficiency of the experiment is thus disturbed, but for all practical purposes the lay-out may be considered satisfactory so long as block size is not unduly large.

(2) A second method of confounding which may be usefully adopted meets the second difficulty. Instead of having all the ultimate treatments in the same block, a complete replication may be sacrificed in such a way that each block may be divided into sub-blocks and sub-block differences may be confounded with higher-order interactions (such as sowing date × spacing × seedling age), and eventually allowing for the confounding in the analysis of variance. This is on the assumption that higher order interactions are small as compared to the experimental errors, and that instead of *adequate replication* which provides the basis for *error*, these interactions may be substituted. Thus a block containing the treatments n, p, k, np, nk, pk, npk and c (control) may be split up into

n	k
p	npk
nk	np
pk	c

so that second-order interactions are confounded with sub-block differences. In the case of those items which are not confounded, *i.e.* which are orthogonal to one another, the usual procedure of computing the sum of squares will be followed but in the case of those confounded, the general method is *fitting constants* to represent those items and calculating the sum of squares due to fitting. But where the design permits to take account of block differences which confound the interactions, it is easier to compensate for such differences, eventually leaving the confounded degrees of freedom orthogonal with the blocks and also with all the other treatments. Designs of particular types alone will answer these conditions and here it is, where confounding is resorted to, a clear idea of the plan and the procedure of analysis is necessary; otherwise the experimenter will be landing himself in extreme difficulties in the matter of analysis.

In India for field experiments non-orthogonal designs are slowly coming in, in different forms, and research is necessary to explore the full possibilities of such designs with correct methods of analysis. Here indeed the Statistician has his part to play, as indeed on so many other matters connected with the field plot technique.

EXPERIMENTS ON PLOT-TECHNIQUE IN INDIA.

From the Indian experimental data available so far, it is apparent that there has been a lack of uniformity in the conduct of field experiments in the several Provinces and States. Not only are the field experiments sometimes not properly planned, but also they are not carried through for a sufficient number of years to allow for a reasonable weather sampling. The various factors governing the error of an experiment—such as the plan of the experiment (*e.g.*, whether it should be of randomised block type, or a particular Latin Square type), or what should be the suitable *plot size* and *block size* and the *border effect*—should be fully examined under Indian conditions. Experiments to decide these factors are in progress in some of the farms, but the results have not been collated to be of much guidance. The usefulness of complex experiments should be fully explored; so also of confounded experiments which will not only economise labour and time but will provide very efficient tests of significance. "Sampling technique" *i.e.* methods of taking samples from experimental plots such as for physiological study, have not been studied yet with different crops. Again, in the case of *manurial* experiments particularly, we should know the residual and accumulated effects of manures for which special planning for experiments is necessary. What are known as "Permanent Manurial Experiments" should be

suitably planned if the results should be of any value.

Enough has been said to show that India should evolve her own methods both in the matter of planning, and in the conduct of agricultural field experiments. A co-ordinating agency is of course necessary, and there is ample scope for mutual fellowship between the statistician and the agricultural experimenter.

The Antianæmic Principle of Liver.

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THE use of liver in the treatment of pernicious anæmia constitutes a striking therapeutic advance of great importance. The idea must have first originated from Whipple and Robschiet Robbins[1] who in their search for blood regenerative foodstuffs found that of all the substances they investigated, liver was most potent as a hæmopoietic material. This discovery led Minot and Murphy[2] in 1926 to make a clinical trial on pernicious anæmia patients and as a result of their classical researches they obtained a remarkable improvement in the blood picture of the treated patients. Since then, there have been a number of investigations supporting their regimen and now we can completely restore the anæmic patients to normal health by administration of liver.

ETIOLOGY OF PERNICIOUS ANÆMIA.

Although the results of Minot and Murphy made it a logical conclusion that pernicious anæmia is a disease due to a dietary deficiency, there were also other theories prevalent to explain its cause. The accumulation of toxins in the body, the infectious disorders in the intestinal flora and the absence of the anti-hæmolytic substance were individually suggested as the causative factors. The exact etiological significance of the defective gastric secretion was first suggested by Fenwick[3] in 1880 and has, since then, been supported by other investigators. Goldhammer[4] has shown that gastric secretion is proportional to the red blood cells and in pernicious anæmia there is a sub-normal amount of gastric secretion also characterised by complete anacidity. Castle and his coworkers[5,6] have shown conclusively that the stomach of a normal human being secretes some enzymic principle which, when allowed to react *in vivo* or *in vitro* with some substance present in the animal proteins of the food, produces the necessary antianæmic factor. The non-occurrence of this reaction in the body is believed to be a defect in the gastric digestion leading to pernicious anæmia. The secretory product is called the intrinsic factor and the substance derived from the food the extrinsic factor. The specific antianæmic principle thus produced is stored in liver from which it is elaborated as required by the bone marrow to produce the normal quota of erythrocytes.

The site and the mode of interaction of these two factors are not known. Their chemical nature is also obscure. The intrinsic factor is believed to be unrelated to either hydrochloric acid, pepsin, rennin or lipase. Klein and Wilkinson[7] have studied this intrinsic factor in considerable detail and have named it enzyme "hæmopoietin". Like most of the enzymes it is destroyed by heat. Griffith[8] has observed that its action is confined to P_H 3·5–5·5. The food factor is, on the other hand, thermostable and is found to be present in beef-muscle, autolysed yeast, rice polishings, eggs and liver. It is not identifiable with any portion of vitamin B complex.[9,10]

Following the earlier papers of Castle and his coworkers, Sergius and Isaac,[11] and Wil-

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1 Whipple, G. H., and Robschiet Robbins, F. S., *Amer. J. Physiol.*, 1925, **72**, 395.

2 Minot, G. R., and Murphy, W. P., *J. Amer. Med. Assoc.*, 1926, **87**, 470; 1927, **89**, 759.

3 Fenwick, S., "On Atrophy of the stomach and on he nervous affections of the digestive organs," J. & A. hhill, London, 1880.

lhammer, S. M., *Proc. Soc. Expt. Biol. Med*, 476.

5 Castle, W. B., and his coworkers, *Am. J. Med. Sci.*, 1920, **178**, 748-764.

6 Castle, W. B., and his coworkers, *Am. J. Med. Sci.*, 1930, **180**, 305; **1931**, **182**, 741.

7 Klein, L., and Wilkinson, J. F., *Biochem. J.*, 1934, **29**, 1684.

8 Griffith, W. J., *Biochem. J*, 1934, **28**, 671.

9 Diehl, F., and Kuhnau, J., *Deutsch. Arch f. Klin. Med.*, 1933, **176**, 149.

10 Lassen, H. C. A., and Lassen, H. K., *Am. J. Med. Sci.*, 1934, **188**, 461.

11 Sturgis, C. C., and Isaac, R., *J. Am. Med. Assoc.*, 1929, **93**, 747.

kinson[12] showed that in some cases stomach preparations were as effective in bringing about the remission of the disease as liver itself. Snapper and Preez[13] have recorded instances where patients refractory to liver treatment responded very well to stomach preparations. This should not be taken to mean that stomach preparations will generally replace the liver therapy. In the instances cited it is likely that the gastric secretion has reacted on the proteins of the gastric tissues themselves to produce the required antianæmic principle.

Another collateral evidence for the interrelationship of stomach and liver in the etiology of pernicious anæmia is furnished by the work of Goodman[14] and others who have shown that after gastrectomy in the pig, the antianæmic potency of the liver becomes progressively depleted and the animal becomes anæmic. But the total extirpation of stomach in man may not necessarily be followed by the development of pernicious anæmia even after some years. Evidence has recently been adduced by Meulengracht[15] that the active principle of the hog's stomach is present largely in the pyloric region where glands of a type closely resembling those of duodenum of both man and the hog are found. Further, the kidney also is known to contain some of the antianæmic principle and this circumstance might delay the onset of anæmia. This latter fact also renders difficult the postulation that disease of the liver may specifically produce an interruption in the metabolism which leads to the production of the active principle. Further work is needed to elucidate these interesting points.

TREATMENT.

For the oral administration, the patients require about half a pound of whole liver or its extract per day and the patient often takes an aversion to injest such large quantities, particularly when the malady is complicated by nausea, vomitting, sepsis, and such other complications. Moreover, oral administration of the liver preparations to patients suffering from a severe type of pernicious anæmia may not prove sufficiently rapid and the presence of strong auto-agglutinants in the patient's blood may render blood transfusion unsatisfactory. More recently, therefore, the extract has been purified free from proteins and such other impurities and rendered suitable for parenteral injections.[16,17] The effectiveness of the parenterally administered material is about 30-40 times as great as when given by oral route. The maximum increase in reticulocyte is also reached sooner than in the case of oral administration.

PREPARATION.

The full liver action of any preparation of liver extract can be secured only by the employment of unexceptional raw material, careful and skilled treatment of this material and a high degree of concentration of the active substances. Three methods are generally in vogue for the preparation of the active liver extract. The first is that employed by Cohn and his coworkers.[18] The raw minced liver is adjusted to a P_H 5·2, extracted with water and the heat coagulable proteins separated by heating the extract to 70°C. It is then concentrated under vacuum, extracted with ether and finally precipitated by alcohol. The other method, described by Castle and Bowrie,[19] is to extract the well-minced liver with ice-cold water for 12–18 hours, remove the heat coagulable proteins and then concentrate the extract. The third method is described in *British Pharmacopœia* and consists in extracting the liver straightaway with 80% alcohol and concentrating the alcoholic extract. All these preparations are suitable for oral administration and for purposes of injection they are further purified by suitable methods.

The fluctuations in the clinical reports of the several preparations thus obtained emphasise the need for a complete study of the conditions for obtaining a highly potent extract.

NATURE OF THE ACTIVE PRINCIPLE.

Although much has been already learned about the therapeutic constituent of liver, its precise nature is still obscure. In the beginning, since iron and copper were known to accumulate in liver, the therapeutic value was

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[12] Wilkinson, J. F., *Proc. Roy. Soc. Med.*, 1933, **26**, 1341.

[13] Snapper, I., and DuPreez J. D. J., *Nederland Tijdschr. Geneeskunde.* 1931, **75**, 29.

[14] Louis Goodman and others, *Proc. Soc. Expt. Biol. Med.,* 1935, **32**, 810.

[15] Meulengracht, E., *Proc. Roy. Soc. Med.*, 1935, **28**, 841.

[16] Wilkinson, J. F., *Lancet*, 1931, **221**, **791**.

[17] Gansslen M., *Klin. Wochschr.*, 1930, **7**, 2099.

[18] Cohn Minot, Alles and Salter, *J. Biol. Chem.*, 1928, **77**, 325.

[19] Castle, and Bowrie, *J. Am. Med. Assoc.*, 1929, **92**, 1830.

ascribed to these inorganic constituents. But very recently it has been definitely shown[20,21] that neither liver ash nor extraneous Iron or Copper produces in pernicious anæmia cases the well-known beneficial effect obtained with liver.

During their fractionation studies, Cohn and his coworkers[18] located the active principle in the filtrate from basic lead acetate. It could be precipitated by phosphotungstic acid giving a fraction containing 19% nitrogen. They carried out a number of qualitative tests and came to the conclusion that the active principle was not a carbohydrate, protein or lipoid, a result which was also supported by Whipple and Robschiet Robbins. In a later paper, Cohn[22] and his coworkers concluded that the active principle is a nitrogenous base, the nitrogen in which exists, as in a secondary or tertiary amine, probably of the pyroll or pyridine group.

West and Nicholas[23] showed that the best fractions prepared contained 12–14% nitrogen and amino nitrogen 20% of the total nitrogen increasing up to 40% after acid hydrolysis. Iron and phosphorus were absent from their preparations while sulphur was found in traces. The fractions gave a positive biuret, diazo and naphthol test, a weak Hopkin's test and a slight lævorotation.

Felix and Fruhwein[24] have precipitated the active principle by adding to the aqueous extract mercuric sulphate in sulphuric acid solution. The active preparations contained at least 7% nitrogen, the amino nitrogen of which did not increase after acid hydrolysis. Their technique, however, suffers from the defect that the use of heavy metals renders the preparation partially inactive.

The researches of West and Howe[25] point to the fact that the active principle is composed essentially of two amino acids, Oxypyrrolin and Oxyglutamic acid, though their possible mode of linkage is still obscure.

The identification of the active principle with β-Hydroxyglutamic acid isolated from the liver was not supported by later work.[26] Similar negative results were obtained with glutathione found in liver by Robert Fleming.[27] Several amino acids were tested for their therapeutic value and although in one or two cases like arginine and sodium glutamate good results were obtained,[28] it was found in general that none of the usual essential amino acids[29,30,31] was individually responsible for the therapeutic action of liver.

Very recently, in May 1935, Dakin and West[32] have obtained a very active preparation by precipitating the commercial liver extract first by Reinecke salt and then by saturation with ammonium sulphate. 30 mg. of their product caused a perceptible reticulocyte response in pernicious anæmia patients. The clinical activity of the product was readily abolished by exposure to cold 0·5 N alkali, by boiling for one hour with 0·5 N sulphuric acid or by salts of heavy metals. On hydrolysis, the active material yielded an aminohexose and the following amino acids:—lysine (4.6%), arginine (13.5%), glycine (4.6%), leucine (20%), hydroxyprolin (10%), asparatic acid (17% and over), and glutamic acid (1.3%). It was also found that on hydrolysis with pepsin, the amino nitrogen did not increase; but on hydrolysis with erepsin, there was an increase in amino nitrogen while the product suffered from a loss of clinical activity. This shows clearly that the substance in question was a polypeptide. Its rough molecular weight was found to be 475–511 and optical rotation, $(L)_D^{20°} = -90°$.

In view of this probable simple polypeptide nature of the active principle, it appears possible to effect a concentration and purification of the extract by a process of adsorption followed by elution. Methods of simple ultra or electro-ultra filtrations of the extract through suitable membranes should also prove most useful in the purification of the active principle.

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[20] Elden and McCann, *Proc. Soc. Expt. Biol. Med.*, 1927-28, **25**, 746.

[21] Jackson, H., Klein, L., and Wilkinson, J. F., *Biochem. J.*, 1935, **29**, 330.

[22] Cohn, E. J., McMeekin, T. L., and Minot, G. R., *J. Biol. Chem.*, 1930, **87**, xlix.

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[24] Felix, K., and Fruhwein H., *Z. Physiol. Chem.*, 1933, **216**, 173.

[25] West, R., and Howe, M., *J. Biol. Chem.*, 1930, **88**, 427.

[26] Rudolph West, and Howe, M., *J. Biol. Chem.*, 1931, **94**, 611.

[27] Robert Fleeming, *Biochem. J.*, 1932 **26**, 461.

[28] Drabkin, D. L., and Miller, H. K., *J. Biol. Chem.*, 1931, **90**, 531.

[29] Keil, H. L., and Nelson, V. E., *Proc. Iowa Acad. Sci.*, 1933, **40**, 103.

[30] Elvehjem and others, *J. Biol. Chem.*, 1931, **93**, 197.

[31] Giorgio Dominici, and Fansta Penati, *Minerva Med.*, 1931, **11**, 413.

[32] Dakin, H. D., and West, R., *J. Biol. Chem.*, 1935, **109**, 389.

ASSAY OF THE POTENCY.

In spite of the several attempts, there has been no simple and satisfactory method of assaying the potency of liver preparations in some measurable units. The development of a suitable method of biochemical assay would be of immense value not only for the progress of further investigations like the comparative study of the various livers for their antianæmic potency but also for the standardisation of dosages. The only reliable method that is now available is by an actual trial upon pernicious anæmia patients and noting the increase or otherwise of the erythrocytes and reticulocytes. But human cases not being generally available for experiment, progress in this direction is bound to be slow. Attempts at developing a simpler method by using animals have met with little success.

McGowan[33] has shown that pernicious anæmia in fowls accompanied by myelocytic proliferation of liver closely resembles the disease in human beings. He used 19 leghorn fowls, subjects of spontaneous attack of disease to determine the minimum dose of liver extract required to produce significant change in the blood picture. The extract was given orally as well as intraperitoneally. Though apparently good results were obtained, the method is only qualitative and needs to be confirmed.

The work of Vanghan *et al*[34] has shown that the administration of substances capable of alleviating pernicious anæmia in man produces a response in healthy pigeons similar to that occurring in clinical cases, thereby providing a biological test for the potency of these substances. Relatively pure liver preparations known to be effective in pernicious anænia administered either by mouth or by intravenous injection gave consistent response by way of rapid increase in the circulatory reticulocytes and a pronounced gain in weight. Continuing the work of these authors, Edmunds *et al*[35] and Peabody and Neale[36] have outlined a method for testing the clinical value of liver preparations by observing their action on healthy pigeons. But when Wills,[37] Heiman *et al*[38] and Gurd[39] tried this method, they found spontaneous fluctuations even in control animals thus giving inconclusive results.

Jacobson[40] has attempted to use guinea pigs for the assay of the antianæmic factor and has even defined the minimum quantity (0·6 gm./Kgm. body wt.) as one guinea pig (G.P) unit.

Deusberg and Koll[41] adopted an *in vitro* method for testing the liver extracts for their potency. The active substance when added to hæmolysed human blood, destroys the active hamoglobin spectrum and methamoglobin takes its place. The interfering substances like iron, sulphæmoglobin can be checked by adding suitable reagents. Deutsch and Wilkinson[42] have recently shown, however, that this method cannot be relied upon since no correlation can be obtained between the clinical activity and methamoglobin production. If it is possible to develop this method, it would no doubt offer advantages over other clinical tests; it would give quick results even with small quantities of the substances.

The production of the actual pernicious anæmia in animals has not been achieved so far. Since there are two factors involved in the etiology of pernicious anæmia it would perhaps be possible to produce the disease by controlling one or the other of these two factors. The most logical way of achieving this, would probably be, by means of a suitable diet. McCarrison[43] has shown that different diets would produce different influences on the gastro-intestinal tract. It remains to be proved by future experiments whether a defective gastric secretion thus produced would not lead to the production of pernicious anæmia. Miller and Rhoads[44] have tried a certain diet on guinea pigs and have produced a disease corresponding

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33 McGowan, J. P., *Arch. Intem. Med.*, 1932, **49**, 26.

34 Vaughan, J. M., Muller, G. L., and Zetzel, *Lancet*, 1930, **218**, 1062.

35 Edmunds, Bruckner, and Fritzell, *J. Am. Pharm. Assoc.*, 1933, **22**, 91.

36 Peabody, W. A., and Neale, R. C., *J. Am. Pharm. Assoc.*, 1933, **22**, 231.

37 Wills, *Brit. J. Exp. Path.*, 1932, **13**, 172.

38 Heiman, Connery and Goldwater, *Am. J. Med. Sci.*, 1934, **188**, 343.

39 Gurd, M. R., *Quart. J. Pharm. and Pharmco.*, 1935, **8**, 39.

40 Jacobson, B. M., *Science*, 1934, **80**, 211; *J. Clin. Invest.*, 1934, **13**, 714.

41 Deusberg, R., and Koll, W., *Arch. f. Exper. Path.*, 1931, **162**, 296.

42 Deutsch, W., and Wilkinson, J. F., *Brit. J. Expt. Pathol.*, 1935, **16**, 33.

43 McCarrison, Robert, "Studies in Deficiency Disease," Henry Frowde, Holder and Stoughton, London, 1921.

44 Miller, D. K., and Rhoads, C. P., *J. Clin. Invest.*, 1935, **14**, 153.

to canine Black Tongue. Specific improvement is noticed in such cases when liver extract is administered. It should, therefore, be a very fruitful line of investigation to try and produce pathological conditions in animals similar to pernicious anæmia by controlling the diet and then test the effect of liver preparations on them.

Another promising line of enquiry into the assay of the antianæmic materials would probably lie in estimating one or two of the component amino acids of the potent polypeptide before and after its hydrolysis. Since the purest preparation of Dakin and West has been shown to contain arginine to the extent of 13·5% and asparatic acid, more than 17%, it should be possible to obtain an idea of the concentration of the active polypeptide by estimating one or both the above constituents. Work in this direction might yield results of great practical utility in the assay of the active principle.

Economic Ornithology in India.

By Sálim Ali.
(Ornithologist, Dehra Dun.)

A CHARGE that has been preferred against ornithologists in India, perhaps not altogether without reason, is that they have been, and are, far too busy "classification-mongering", *i.e.*, quibbling over morphology and taxonomy, to bother about the *living* bird. Upto a point it may be argued in their defence that before biological studies on any group of animals can be undertaken it is essential that the forms belonging to that group should first be properly classified and made cognisable. But while acknowledging the stirling work done in this direction by ornithologists—wholly European—during the last century and still being carried on by their torch-bearers to-day, there is no doubt that the various other aspects of Indian ornithology have suffered a corresponding neglect.

The Indian Empire encompassing as it does an infinite diversity of climates and physical features—ranging from the eternal snows of the Himalayan peaks to the torrid deserts of Rajputana and Sind—contains an avifauna that for richness and variety can scarcely be rivalled by areas of similar size elsewhere in the world. The total number of species and sub-species so far described is just over 2,350 (including about 350 winter visitors) and more are being added to the list as fresh material from insufficiently worked areas or groups becomes available. Notwithstanding this prodigality of material, our knowledge of the living bird in India is surprisingly meagre. Beyond the barest facts about the nests and eggs of most (but still not all) of them, we know practically nothing concerning their breeding biology. The study of migration—one of the most engrossing of bird activities and one that has stirred Man's wonderment from the earliest times—is here still in its veriest infancy compared with the researches and the strides being made in Western countries. Bird ecology, despite the vast natural facilities, remains practically an untouched and virgin field, while Economic Ornithology—an aspect of bird study that should have been, if for purely materialistic reasons, one of the foremost to receive attention in an agricultural country like India, has not even been scratched on the surface.

Besides being a source of direct food supply to millions of human beings in this country, it is little realised that wild birds stand in a class by themselves—second only, if at all, to predaceous and parasitic insects—as destroyers of, and natural checks on, harmful insect pests and other vermin, and as agents in the cross-pollination of flowers and the dissemination of seed. Directly or indirectly they exert their influence in practically every branch of human industry.

Economic Ornithology is the science that concerns itself with striking a precise balance between the damage caused by birds to Agriculture, Horticulture, Forestry and other human interests as against the active benefits they confer in less obvious ways. An increasing amount of importance is being attached in recent years to this science in Europe and America with excellent and far-reaching results. In the United States there is a well-organised department carrying on continuous and intensive research work on the life-histories of birds with special reference to their food and feeding habits under the Bureau of Biological Survey, a subsidiary

branch of the U. S. Department of Agriculture.

The only attempt systematically made with the object of evaluating the economic status of birds in this country was an investigation on the food of certain birds by Mason and Lefroy at Pusa. The results, published as a *Memoir of the Department of Agriculture in India* (Vol. III, Entomological Series, 1912), while meagre in extent and circumscribed in scope, demonstrate the vast possibilities and usefulness of this type of research in India. Their weakness lies in the fact that they deal only with adult birds whose diet we know often differs completely from that of juveniles. In Fringilline birds for instance—the tribe to which our common Sparrow belongs—the food of the young consists almost entirely of caterpillars, moths and other soft-bodied insects while that of the adults is almost exclusively seeds and grain. The investigations fail to appraise the *whole* value or status of the birds since they completely overlook this phase of their life-histories. Besides, it is felt that the studies that have been made by an analysis of stomach contents in different months of the year cannot really be appreciated without a knowledge of the density of the bird population on areas of various types and at different seasons. The taking of bird censuses has not been carried out anywhere in India at all. A number of methods for doing this have been employed successfully in Europe and America, none of which could perhaps be applied in their entirety to Indian conditions but which it should not be difficult to adapt. Active co-operation would be necessary from a band of workers, whom it should be possible to find among the biology undergraduates of our various colleges and universities. Tracts of from 40 to 80 acres have been found to be conveniently controlled by one person, but in many areas in India, owing to the density of bird population and other factors, 20 to 25 acres will probably be found to be a more suitable unit. Counts are made at frequent intervals of all birds present in the controlled areas and also of the breeding population of certain selected species over much larger areas by counting their nests.

The study of bird movements is also obviously important from the economic point of view, and it is thought that investigations of methods of catching birds for marking would lead to greater numbers being marked and thus to more rapid progress in our knowledge of their movements. The method of marking or "banding" birds has been widely employed in Europe and America since the beginning of the present century, but perhaps more systematically and intensively after the War. It consists of fixing on the leg or tarsus of a bird of an aluminium ring of appropriate size on which is stamped a serial number and the address of the ringer. A register is kept by the ringer in which are noted down the species, date of marking, sex, age and other particulars of the ringed bird against the corresponding serial number. The bird is then released, the idea being that if it is subsequently shot or captured the particulars of the date and place of taking and other details would be communicated by the recoverer to the address on the ring. By a recovery of ringed birds in sufficient numbers and a collation of the data it has been possible to build up a great deal of invaluable information concerning the migration and local movements of many species, the age to which they live and other details of their individual life-histories impossible to obtain in any other way.

It will be seen, therefore, that Economic Ornithology does not merely end with the ripping open of the stomachs of birds and listing up their contents, but involves a great complexity of other investigation and study besides. Mason and Lefroy's paper is an attack on but one facet of a many-sided problem, though admittedly the most important contribution that has yet been made to the subject in India. It may be mentioned, however, that the numerical method which C. W. Mason principally employed and the merits of which he so strongly advocates, *i.e.*, of reckoning stomach contents of birds solely by the number of individual insects or seeds, has been well shown by Mr. W. L. McAtee[1] to be vague and often insufficiently illuminating. The principal objection to the numerical method is that it takes no account of the size of the objects eaten and hence conveys no idea to those unacquainted with the groups concerned of the relative importance of the food elements. On the other hand, under the volumetric method which has been in continuous use by the Biological Survey of the U.S. Department of Agriculture since 1895, the proportions the various food elements contribute to the bird's subsistence

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[1] W. L. McAtee, "Methods of estimating the contents of Bird Stomachs," *The Auk*, Oct. 1912, 29, No. 4.

are evident at a glance and the bird's capacity for good or harm are clearly indicated. Both methods have their weak points, however, and Mr. McAtee suggests that the ideal technique is one that combines the good points of both the numerical and the volumetric methods.

The following, in general terms, are the harmful and beneficial activities of birds:

Harmful (H):

1. Damage to cereal crops, fruit, vegetables, etc. and destruction of useful insects, fish, etc.
2. Intermediate hosts of parasites which may be dispersed far and wide by their migrational movements and spread diseases among Man and Animals.
3. Dispersal of noxious weeds, etc

Beneficial (B):

1. Destruction of insect pests, refuse, rats, mice and other vermin which are not only destructive to agriculture and other branches of human industry, but carriers of diseases of Man and Animals.
2. As agents of cross-pollination of flowers and dispersal of seed, and hence as regulators of vegetation.
3. As source of supply of meat, feathers, guano and other useful and commercial products.

To take these various activities in some detail:—

(*H*) 1.—Crows, Mynahs, Parakeets, the Fringilline birds and others cause damage to ripening crops of Maize, Jowari, Bajri, Wheat, Paddy, etc., which is occasionally considerable in extent. Migratory ducks, coots, geese and cranes do extensive damage in certain areas to rice, gram, wheat and other crops. From a scrutiny of the stomach contents and feeding habits of Rosy Pastors in the Nander District of Hyderabad recently, it was estimated[2] that a flock of 400 birds would account for 25 lbs. of Jowari in one day, equivalent to the food of an average villager for 10 to 12 days! As there are thousands of these birds continuously at work all through the ripening period of Jowari, it is not difficult to realise the magnitude of the damage they cause. Mr. K. V. Joshi, Deputy Director of Agriculture, Bombay Presidency, roughly estimates that the damage done by these birds to cereals in some talukas of S.-E. Khandesh is about 15 per cent. of the total crop.

Crows, Mynahs, Starlings, Parakeets, Bulbuls and Barbets are some of the principal despoilers of orchards and vegetable gardens. Mangoes, apples, pears, plums, peaches, cherries, litchies, guavas, tomatoes, green peas, etc., are some of the more important sufferers.

Bee-eaters occasionally do some damage by destroying honey bees, but this is on the whole negligible. Aquatic birds have important relations with the fishing industry. Grebes, Cormorants, Herons, Gulls and Kingfishers have often been accused and convicted for causing serious reduction of food fishes, but a careful study of their food habits by the Biological Survey of the U. S. Department of Agriculture has demonstrated that only a small proportion of their diet consists of such fishes, their staple food being crawfish, crustaceans and insects some of which are more injurious to the fry of food fishes than the birds themselves. Trout fry studies by the Biological Survey reveal that the greatest amount of disappearance, which less careful observers are inclined to attribute to birds, is caused by enemy or competitor fishes. Few realise what serious destroyers of spawn there are among the fish themselves, which have frequently well-developed cannibalistic tendencies. Larvæ of water beetles, nymphs of dragonflies, water-bugs and crayfish are some of the worst offenders. Birds eat all these and on the whole probably more than compensate for any direct loss they may cause to the fry. Moreover, most edible fishes of any value live in deeper water and are, therefore, immune as a rule from depredations by Herons, Egrets, etc., who keep close to the shore and devour whatever can be most easily procured. In this way they sometimes eat numbers of catfish which are indeed notorious spawn eaters. Fish-eating birds do most damage about hatcheries as has been the experience during the introduction of trout into the Nilgiris and Kashmir, and here their numbers need to be controlled.

(*H*) 2.—Very little work has so far been done even in Europe and America—and practically none in India—on the subject of the dispersal by birds of diseases of Man and Animals. It is an investigation pregnant with possibilities and obviously of the greatest importance to health and sanitation as well as to animal husbandry and agriculture, especially as birds are well

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[2] Sálim Ali, "The Hyderabad State Ornithological Survey," *Jour. Bom. Nat. Hist. Soc.*, 1933, **36**, 365.

known to be the hosts of a large variety of both ecto- and endo-parasites which their far-flung wanderings may help to disperse. Thus Sparrows introduced into North America are responsible—or at least blamed—for spreading among poultry certain diseases such as "Blackhead" due to parasitic Coccidea. Some of the worms found almost exclusively in birds belong to the following classes: Trematoda, Cestoda, Nematoda, Acanthocephalidæ and Pentastomidæ. Among the Arthropoda several forms of Acari are known to be ecto-parasites of birds, and among insects numerous forms of Aphaniptera, Rhynchota, Diptera and Mallophaga are prominent.

Of the Trematodes and Acanthocephalidæ many need two intermediate hosts, the last of which forms the principal food of the birds. For example, one common Trematode of the gut of *Hirundinidæ* (Swallows) and *Micropodidæ* (Swifts)—*Plagiorchis maculosus* Rudolphi—has in the larval or miracidium stage to enter a fresh-water snail (*Limnæa*) where it multiplies parthenogenetically. The cercaræ leave the host by hundreds and find their way into the larvæ of mosquitoes (*Chironomis*, etc.), survive the insects' metamorphosis and are swallowed along with the host by swallows and swifts. They develop and reach sexual maturity in the small intestine of these birds, the eggs being passed out with the fæces of the hosts and requiring to reach the water for their development.[3]

(*H*) 3.—No better instance of the harm done by birds in the dispersal of noxious weeds can be cited than the phenomenal spread in India of that pernicious exotic weed *Lantana camara*. This plant, of Mexican domicile, first imported into Ceylon for ornamental purposes just over a hundred years ago, has since overrun thousands of square miles of the peninsula and become the despair alike of agriculturist and forester. Its widespread dispersal within such a comparatively short period would have been impossible without the agency of birds, numerous species of which extensively devour its berries which the plant everywhere produces in overwhelming profusion. I have observed an Oriole (*Oriolus kundoo*) swallowing 77 berries in the course of 3 minutes! The seeds pass through the birds' intestines unaffected (negatively at least) by the gastric secretions and out with the fæces, germinate rapidly under favourable conditions and establish themselves.

Another plant that does considerable damage to trees of many kinds both in forest and orchard, causing financial loss to the mango-grower which, were it possible of assessment, would run into lakhs of rupees annually, is the *Loranthus* tree-parasite. It belongs to a family, well represented in India, almost all of whose members are more or less wholly symbiotic with Sunbirds (*Nectarinidæ*) and Flowerpeckers (*Dicæidæ*) and other species which both fertilise its flowers and disperse its seeds.[4]

Having dealt briefly with some of the actual as well as hypothetical or alleged harm from which man suffers or may suffer at the hands of birds, it is fitting to discuss some of their activities which are decidedly beneficial to his interests.

(*B*) 1.—It has been observed by the French writer Michelet that the Birds could exist without Man, but that Man would perish without the Birds, and Buckland[5] observes that "But for the trees the insects would perish, but for the insects the birds would perish, and but for the birds the trees would perish; and so follow the inexorable laws of nature to the conclusion of their awful vengeance, but for the trees the world would perish." An impartial analysis of the evidence, both direct and circumstantial, shows that there is, indeed, little extravagance in either of these statements. The number, fecundity and voracity of insects are unbelievable. Over 300,000 forms have been described and it is considered not improbable that twice that number still remain to be described. In the Indian Empire alone more than 30,000 forms are known. Practically all living animals as well as most plants furnish food for these incomputable hordes. Many estimates have been made of what a single pair of insects would increase to if allowed unchecked multiplication, and astounding figures have been reached, rivalling in their stupendousness those which we associate with astronomical calculations. A Canadian entomologist estimated that a single pair of

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[3] Stresemann, E., *Handbuch der Zoologie-Aves.*, Berlin, 1933, p. 712.

[4] Sálim Ali, "The Rôle of Sunbirds and Flowerpeckers in the Propagation and Distribution of the Tree-parasite *Loranthus longiflorus* Desr. in the Konkan," *Jour. Bom. Nat. Hist. Soc.*, **35**, 145-49.

[5] Buckland, James, "The Value of Birds to Man," *Ann. Rep. Smithsonian Inst.*, Washington, 1913, 439-58.

provide an item to their credit which probably far outbalances the harm they do. Rosy Pastors are also greatly relished as an item of food and thousands upon thousands are netted or slaughtered every year in North-west India and elsewhere during the autumn and spring migrations, especially the latter as the birds are then very fat.

The working of the Wild Birds and Animals Protection Act and similar measures has put a check upon the exploitation of birds for the plumage trade. Feathers are largely used in the millinery business and although modern trend in women's fashions has for the time being made them less popular than they were some years ago, there is still a vast and lucrative demand from abroad, both the Eastern countries and Europe. With a scientific determination of the economic status of various species of our commoner birds and a regulated system of controlling the numbers of the more or less undoubtedly harmful ones, such as the parakeets apparently are, there is no reason why the plumage trade should not be legitimised and even encouraged to become a fruitful source of revenue, which could be earmarked for the furtherance of research in Economic Ornithology and for measures of conservation. Apart from revenue considerations, the legalisation of the plumage trade under an officially regulated and controlled system would give fillip to the farming of certain birds such as egrets for the sake of their valuable plumes. Egret-farming is a potentially profitable cottage industry extensively practised at one time by the lacustrine section of the population in Sind. It is now dwindling in importance owing to the complete ban on exports of feathers to foreign countries and the consequent narrowing down of the market to local demand chiefly in Calcutta.

A few years ago certain suggestions were put before the local government by the Bombay Natural History Society for the permitting of export under officially certified and sealed packages of egret feathers produced in these farms in order to revitalise the industry, but as far as is known the suggestions have not been given effect to.

There are other minor products of birds which, if properly husbanded, could be made to yield considerable revenue in India. The saliva nests of the Edible Swifts (*Collocalia*) which breed in vast colonies in caves on islands off the Burma coast are even now the source of a considerable income to the Government. They are collected and exported to China as a table delicacy and the better qualities fetch from 10 to 20 dollars (= approximately Rs. 8-4-0 to Rs. 16-8-0) per catty ($1\frac{1}{4}$ to $1\frac{1}{3}$ lb.). The value of nests imported into China during 1923, 1924 and 1925 exceeded a million tael (Rs. 25,00,000). More than half this amount came from the port of Shanghai, mostly from Singapore, Java and Hongkong but also from India and French Indo-China.[10]

Guano, which is really the excrement of sea birds such as gannets, cormorants and pelicans, is another product of great commercial value. The fertilising properties of the phosphoric acid and nitrogen contained in fish was not recognised until guano became a stimulus to intensive agriculture. The real guano is found in vast stratified accumulations on islands off the Peruvian coast, and although no deposits of anything like the magnitude or value of those on Chincha Island exist within our limits, still the sources and possibilities of the "guano" of colonial nesting birds have not been sufficiently explored in India.

CONCLUSION.

Sufficient examples have been given to show that a scientific investigation of the life-histories of birds generally is worthwhile from the economic point of view. The potentialities of research in Economic Ornithology in an agricultural country like India are unbounded. In its bearings and ramifications the subject is in no wise less important than Economic Botany or Economic Entomology which, under official recognition, have already made such good progress in this country. It is suggested that research in Economic Ornithology should also be similarly encouraged. It should be taken up in earnest by the Imperial Council of Agricultural Research under whose ægis it should become an All-India—or under the impending reforms, a Federal—function as it is in the U.S.A. The migrations of birds, in addition to their ordinary free movements, carry them to all parts of the country, and therefore the only adequate survey of their economic relations can be the one that takes in their entire range regardless of provincial boundaries.

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[10] Sowerby, Arthur De C., "The Edible Birds' Nest Swift," *China Journal*, March 1931, **14**, 135-137.

Centenaries in January 1936.

Lagrange (Joseph Louis), 1736-1813.

TWENTY-FIFTH of January 1736 saw the birth at Turin of one of the greatest French mathematicians. At school his boyish interests were Homer and Virgil. At the age of seventeen, he chanced to read Halley's *A new, exact and easy method of finding the roots of any equations generally, and that without any previous reduction*, published in 1694 in volume 18 of the *Philosophical Transactions* of the Royal Society. This kindled the mathematical spark in him. Like Newton, but at a still earlier age, he reached to the heart of the matter in an incredibly short time.

INVENTS CALCULUS OF VARIATIONS.

In these days when our Universities and Departments of Education are vying with one another in fixing absolutely rigid age limits for admission to the University, it is specially interesting to note that at the age of 18, Lagrange was appointed professor of mathematics in the Royal School of Artillery at Turin. When he was but 19, his attack on the isoperimetrical problem led to his invention of the new *Calculus of Variations*. This Calculus is intimately related to the story of Least Action which began with the reflecting mirrors of Hero, interested Descartes, led to Hamilton's principle and is still persisting to-day in the development of Wave Mechanics.

FOUNDS TURIN ACADEMY.

In 1758, he was at the head of a youthful band of scientists who became the foundation members of the Turin Academy of Sciences and he contributed several papers to the *Miscellanee Taurinensia*, which was the organ of the Academy. He was awarded the prize of the French Academy of Sciences in 1764 for an essay on the *Libration of the Moon* in which he used his well-known equations for the first time. He won this prize in several later years, *viz.*, 1766, 1772, 1774 and 1778.

SUCCEEDS EULER.

In 1776, the great Euler of the Academy of Berlin recommended him to be appointed his successor. Frederick the Great accepted the recommendation with the remark that "The greatest king of Europe" should have "the greatest mathematician of Europe" in his court. While at Berlin, Lagrange contributed several learned papers, which culminated in the *Mechanique analytique*, which Hamilton described as "scientific poem". This was published at Paris in 1788 under the supervision of Legendre.

SETTLES IN FRANCE.

After the death of Frederick the Great, Lagrange accepted the invitation of Louis XVI to Paris. He was lodged in Louvre with a pension of 6,000 francs. In 1791 he was elected foreign member of the Royal Society of London. He commanded universal respect even in the crisis of the Revolution. He was one of the first members of the Bureau des Longitudes. He supported the adoption of the decimal and metrical system. When someone defended twelve because it has more factors, Lagrange remarked what a pity it was that the number eleven had not been chosen as the base, because it was prime.

LAST YEARS.

In his later life, mathematicians thronged to meet him and to show him every honour, but they were dismayed to find him distracted, melancholy and indifferent to his surroundings. The years of activity had told; and Lagrange was mathematically worn out. He directed his thoughts elsewhere—to metaphysics, religion, medicine and chemistry. He found chemistry, however, to be as "easy as algebra". He began his revision of his *Mechanique analytique* in 1810; but did not live to complete the revision. He died at Paris, 10th April 1813.

In the words of Turnbull "Lagrange is one of the greatest mathematicians of all times not only for the abundance and originality of his work, but for the beauty and propriety of his writings." His complete works were edited by Serret and Darboux and were published in fourteen sumptuous volumes between 1867 and 1892. His biography published in the *Memoires de l'Institute*, by Delambre in 1812 is reproduced in Volume I of the collected works. The last two volumes are also of biographical interest as they contain his correspondence with the chief mathematicians of his time such as Clairaut, D'Alembert and Euler.

S. R. RANGANATHAN.

Watt (James), 1736-1819.

SIX days before Lagrange was born, one of the front rank engineers, whose inventive talents have conferred immeasurable benefits on the human race, was ushered into the world at Greenock in Scotland. James Watt was jeered by his school fellows as being dull and spiritless. But even in his sixth year, he was solving geometrical problems, experimenting with a tea kettle and drawing machines. His father was a mathematical instrument maker and he was 'a diligent worker in his father's shop and gave early evidence of his manual dexterity'.

HIS EARLY CHANCES.

Having spent a year as an apprentice to John Morgan, the "philosophical instrument maker", he went to Glasgow in 1756 and tried to establish himself as an instrument maker. But the city guilds prevented this on some formal grounds. It was at this juncture that the University of Glasgow came to his assistance by appointing him as a mathematical instrument maker to the University and by allowing him to establish a workshop within its precincts. Here he worked from 1757 to 1773 and made the acquaintance of eminent men such as Joseph Black, the discoverer of latent heat. Here also, in 1764 occurred the well-known incident of the repair of the model of a Newcomen steam engine, belonging to the University.

HIS INVENTION.

While repairing this engine, he calculated the abnormal loss of heat and was filled with an ardent desire to reduce the heat losses. This desire was working in his mind till, one day in 1765, the fertile idea of the condenser appeared. The phase of sudden revelation, which followed several weeks of unconscious work, is best described in his own words. "It was in the Green of Glasgow. I had just gone to take a walk on a fine Sabbath afternoon. I had entered the Green by the gate at the foot of Charlotte Street—had passed the old washing house. I was thinking upon the engine........and gone as far as the Herd's House, when the idea came into my mind that as steam was an elastic body it would rush into a vacuum, and if a communication was made between the cylinder and an exhausted vessel, it would rush into it and might be there condensed without cooling the cylinder. I then saw that I must get quit of the condensed steam and injection water, if I used a jet as in Newcomen's engine. Two ways of doing this occurred to me. First the water might run off by a descending pipe, if an offlet could be got at a depth of 35 or 36 feet, and any air might be extracted by a small pump; the second was to make the pump large enough to extract both water and air...... I had not walked further than the Golf House when the whole thing was arranged in my mind."

The invention was made. It remained to be completed by new experiments. A series of condensers were made, each more perfect than its predecessor, until the first large-scale engine was erected near Linlithgow and the first patent was obtained in 1769.

SOHO IRONWORKS.

In 1775, Watt entered into partnership with Mathew Boulton of Soho near Birmingham, when the manufacture of the condensing steam engine was commenced on a large scale. This partnership was a fortunate one for Watt — Boulton was bold and enterprising; Watt was timid and shrank from the commercial side of affairs.

LAST YEARS.

He retired from business in 1800. But he showed the same alert and active mind even after retirement. His last work was the invention of machines for copying sculpture. We find him not many months before his death—the end came on August 19, 1819—presenting copies of busts to his friends as the work "of a young artist just entering on his eighty-third year".

The attic room of his house—the Watt Room—where he used to work alone is still preserved in its old condition. An exhaustive account of his many inventions is given by Edward A. Cowper in the pages of the *Proceedings of the Institution of Mechanical Engineers* for 1883.

In the field of pure science, Watt's paper entitled *Thoughts on the constituent parts of water and of dephlostigated air, with an account of some experiments on the subject* and published in the *Philosophical Transactions* of 1784 gives him the claim as a discoverer of the composition of water.

S. R. RANGANATHAN.

Letters to the Editor.

The Electric Discharge in Gases and the Debye-Hückel Theory.

IN view of the remarkable success of the Debye-Hückel theory in the field of the kinematics of ions in liquid media, it is not a little surprising that but little use of its methods has been made in the analysis of the phenomena in the discharge tubes. The object of the present note is to direct attention to a possible treatment of the familiar cathode-fall effects from the standpoint of the theory.

It is easily shown that even in the intense[1] type of electric discharge the condition of the gas at these low pressures is analogous to that of an electrolytic solution at great dilutions. For simplicity, the case of singly charged positive and negative ions will be considered here. Making the same assumptions as made by Debye-Hückel[2] in the development of their theory, we arrive at a similar differential equation:

$$\text{div grad. } V = \nabla^2 V = K^2 V \quad .. \quad (1)$$

for which a solution is now sought, having cylindrical symmetry. In the above equation K is a constant and V is the potential at any point (r, z, ϕ), V being supposed to be such that power terms of $\frac{eV}{kT}$ higher than the first can be neglected (where e, k and T have their usual significance) *i.e.*, $V \ngtr 30$ kv for ordinary temperatures.

The solution obtained is

$$V = [\,A + A'e^{Kz}]\,[B - \frac{B'r^2}{c^2} - \,..] \qquad (2)$$

where c is the radius of the discharge tube and A, A′, B and B′ are constants, to be evaluated from initial conditions. The conditions of the problem are assumed to be such that when $z = 0$, $V = 0$, $\left(\frac{\partial V}{\partial z}\right)_{z=0} = 0$.

Applying this equation to the variation of the length of the cathode-fall with the voltage-drop across it, it will be easily seen that the former will vary as the logarithm of the latter. This is actually found to be the case as a first approximation, in the experiments on cathode-fall length for varying voltages using positive rays of hydrogen.[3]

The theory can easily be extended to take into account the different types of ions present, the effect of the space charge at the cathode, the perturbation of the equilibrium conditions due to the passage of the current, etc., to be treated elsewhere.

In the end, it should be remarked that the chief value of the Debye-Hückel procedure lies in the fact, that it does not contemplate any specific kinematical picture of the reactions going on in the system, but makes use of only general statistical methods.

Physical Laboratory, V. T. CHIPLONKAR.
Benares Hindu University,
December 19, 1935.

[1] Townsend, J. S., "Electricity in Gases," Oxford, 1915; Millikan, Gottaschalk and Kelly, *Phys. Rev.*, 1920, **15**, 157.

[2] Taylor, H. S., "Treatise on Physical Chemistry," Macmillan & Co., Second Edition, **1**, 785.

[3] Dasannacharya, B., and Das, G. K., *Proc. Ind. Sci. Cong.*, 1936, Indore, Phys. and Math. Section.

A Zonal Effect in the Electrolytic Coagulation of Colloid Manganese Dioxide.

EARLIER results[1] for the viscosity changes consequent upon the *slow* coagulation of a number of sols have shown the difficulty of reconciling experimental results with the chief assumption made in Smoluchowski's theory[2] of the kinetics of coagulation, *viz.*, that the change is but a time continuous coalescence of the micella. An additional support to this criticism was afforded in the measurement of μ the refractive index of a number of sols during coagulations. The curves in Fig. 1 show the course of μ-change

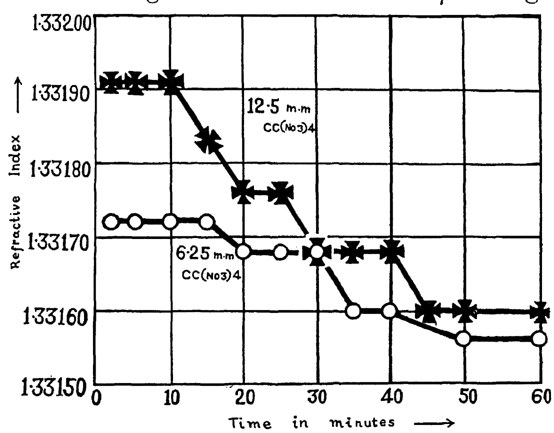

Fig. 1.

during two typical coagulations of the above sol by solutions of cerium nitrate. On general considerations it is seen that μ depends upon the total optical path for a given light beam passing through the colloid. This, in part, is constituted by the dispersed material. It is expected, therefore, that μ would alter due to micellar changes during

coagulation. The curves in Fig. 1 show in a striking manner the essential discontinuity characteristic of the course of the reaction, observed with a means markedly different from that employed previously.[1] This appears to be a general result at any rate in the *slow* region, as judged from data of over 80 cases examined in these Laboratories. Its prediction constitutes one of the chief criteria of the validity of any theory for both the kinetics and the mechanism of coagulation.

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December 30, 1935.

[1] Joshi and Viswanath, *J. Indian Chem. Soc.*, 1933, **10**, 329; Joshi and Menon, *ibid*, 1933, **10**, 599; Joshi and Nanjappa, *ibid.*, 1934, **11**, 133; Joshi and Iyengar, *ibid.*, 1934, **11**, 555, 573; Joshi and Panikkar, *ibid.*, 1934, **11**, 797; also *Journ de. Chim. Phys.*, 1935, **32**, 455.

[2] *Z. Phys. Chem.*, 1917, **92**, 129.

The New Orienting Rule of Svirbely and Warner.

THE new empirical rule in aromatic substitution, recently enunciated by Svirbely and Warner[1] as generally applicable, connecting the electric moment of the benzene derivative and the directive power, is open to many objections.

Claiming that there were only three definite exceptions to the rule, *i.e.*, the cases of benzoic acid, methyl and ethyl benzoates for which moments less than 2·07 D have been recorded,[2] the authors, apparently to justify their rule, have revised the moments of the last two compounds to 2·43 and 2·52 respectively and have advocated a redetermination in the case of benzoic acid. Without digressing about the validity of the experimental method adopted in their revision, we point out that Bergmann and Weirmann[3] could, once more, only obtain the value of 1·91 for methylbenzoate and from what follows, it can be inferred that the rule is not based on grounds too solid to predict with certainty a moment greater than 2·07 D either for benzoic acid or for these esters.

Leaving aside the notorious case of the nitrosogroup, it is pointed out that benzoin,[4] deoxybenzoin,[5] and dibenzylketone,[6] which have been classified by the authors as *meta* directing in accordance with their rule because of their moments 3·4, 2·95 and 2·65 respectively, have actually been found to have the opposite effect! The failure of the rule in these cases is strictly in accordance with the expectation of the modern theories of aromatic substitution,[7] and is not to be attributed to any of the factors referred to by the authors. It can also be predicted safely that the rule is bound to fail in the cases of the substituents like $-CH_2.CH_2.CO.C_6H_5$, $-CH_2SO.C_6H_5$, $-CH_2.SO_2.C_6H_5$, $-CH_2.SO_2.CH_2.C_6H_5$, etc., all of which are expected to possess moments higher than 2·07 D but direct only to *ortho* and *para*.

Further, the following substituents have all been found to be *ortho* and *para* directing but possess moments[8] greater than 2·07 D: $CH:CH.CHO$[9] (3·71); $-CH_2.CN$[10] (3·56); $-CH:CH.CO.CH_3$[11] (3·3); $-N(NO).C_6H_5$[12] (3·39); $-SCN$[13] (3·00).

The dipole moment of the molecule can be claimed to bear a direct relation, as suggested in the rule, to the directive capacity of the substituent only if, according to the Robinson-Ingold theory of aromatic substitution, it decides the electronic disposition, as governed by the general polar and tautomeric effects, of the bond between the nuclear carbon and the attached atom of the substituent group. But this is not the case always[14] particularly with complex substituent groups, where the rule has been shown to fail. If we consider the directive capacity of a *meta* directing group R with a high moment (*e.g.*, NO_2, CN, SO_2R') when attached to the ring through methylene groups (as in $-CH_2.R$, $-CH_2.CH_2.-R$), we find that even by the intervention of one carbon atom between R and the ring, the substituent becomes *ortho* and *para* directive, though the moment remains but little altered. Thus it is clear that this "measurable property of the molecule," the dipole moment, can be connected with the directive power only with strict limitations.[15]

K. GANAPATHI.
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore,
January 11, 1936.

[1] *J. Am. Chem. Soc.*, 1935, **57**, 655.

[2] Table of Dipolements, *Trans. Farad. Soc.*, 1934, **30**, Appendix.

[3] *J. Am. Chem. Soc.*, 1935, **57**, 1755.

[4] Chattaway and Coulson, *J. Chem. Soc.*, 1928, 1081.

[5] Pictet, *Ber.*, 1886, **19**, 1064; List, B., *ibid.*, 1893, 26, 2452; Golubew, *ibid.*, 1878, **11**, 1939.

[6] Manchot and Krische, *Ann.*, 1904, **337**, 176; Manchot and Zahn, *ibid.*, 1906, **345**, 331.

[7] Waters, *Chem. Rev.*, 1930, **7**, 409, 420.

[8] *Cf.* ref. 2 for the moments recorded.

[9] Diehl and Einhorn, *Ber.*, 1885, **18**, 2336.

[10] Flürscheim and Holmes *J. Chem. Soc.*, 1928, 2330.

[11] Baeyer and Drewsen, *Ber.*, 1882, **15**, 2859; *ibid.*, 1883, **16**, 1954.

[12] Julliard, *Bull. Soc. Chim.*, (3) **33**, 1173.

[13] Challenger and Collins, *J. Chem. Soc.*, 1934, **125**, 1377.

[14] Robinson, *Soc. of Dyers and Colourists*, 1934, Jubilee Vol., p. 75; *cf.* Smith, *Trans. Farad. Soc.*, 1934, **30**, 754, 758.

[15] *Cf.* Sutton, *Proc. Roy. Soc.*, 1931, **133A**, 668.

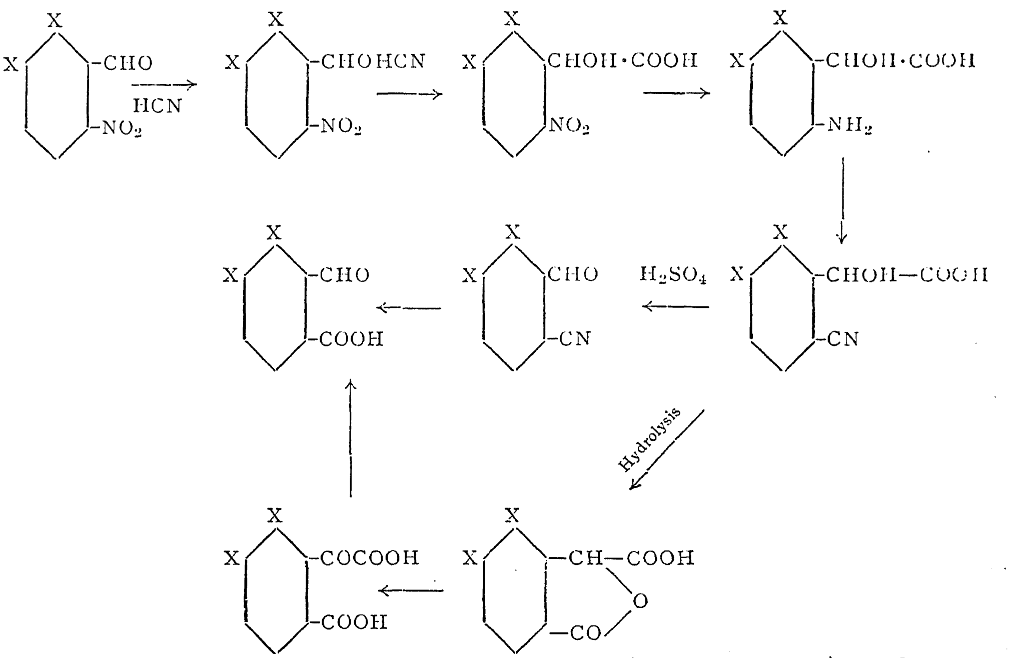
A New General Method for the Synthesis of Substituted Phthalid-Carboxylic Acids.

(A Preliminary Note.)

IN a recent paper, one of us critically examined the various methods available for the synthesis of substituted phthalide-carboxylic acids.[1] During the course of synthetical experiments on *o*-cyano-aldehydes, none of which have so far been synthesised, we have incidentally discovered a simple method of synthesising phthalide-carboxylic acids, which should be capable of wide extension. All attempts in the past to convert *o*-aminoaldehydes into *o*-cyano-aldehydes by the usual Sandmeyer's reaction have been unsuccessful.[2] Attempts to convert the Schiff's bases, acetals, and oximes of the corresponding *o*-aldehydo-amines into the corresponding cyano-compounds have, also, not been, so far, very successful.[3] It has been found, however, that *o*-amino-cinnamic acids, which could be readily obtained from the corresponding *o*-nitroaldehydes, can be smoothly converted into *o*-cyano-cinnamic acids, and the latter can be oxidized in poor yields to the corresponding *o*-cyano-aldehydes.[4] In view of the poor yield of the oxidation product, we next attempted the synthesis of *o*-cyano-aldehydes and *o*-carboxy-aldehydes in the manner shown below.

We have found that *o*-nitromandelic acid and substituted *o*-nitromandelic acids can be smoothly converted into the corresponding amino-mandelic acids through ferrous sulphate and barium hydroxide.[5] The sodium salt of the amino-mandelic acids were then diazotized under strictly defined conditions and converted into cyano-mandelic acids through the aid of Sandmeyer's reaction. The latter type of acids on hydrolysis gave the corresponding phthalide-carboxylic acids in fair yields.

This method of synthesis of the substituted phthalide-carboxylic acids should be of considerable interest as phthalide-carboxylic acids, *e.g.*, meconinecarboxylic acid, form the essential starting substance for the synthesis of the alkaloids of Berberine type by the method of Perkin, Ray and Robinson.[6] Moreover, the phthalide-carboxylic acids could be readily oxidized to the corresponding phthalonic acids, and the latter converted into the corresponding *o*-aldehydo-carboxylic acids.[7]



(X = H, or OCH_3)

The detailed account of these experiments would be published elsewhere.

S. K. CHAKRAVARTI.
P. R. VENKATARAMAN.

Annamalai University,
Annamalainagar,
January 6, 1936.

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[1] Chakravarti and Swaminathan, *J. Annamalai University*, 1935, **4**, 44.

[2] Compare Rilliet and Kreitmann, *Helv. Chim. Acta.*, 1921, **4**, 596; Chakravarti, *J. Indian Chem. Soc.*, 1929, **6**, 208.

[3] Unpublished work, Chakravarti and K. Ganapati.

[4] Chakravarti and Ganapati, unpublished work. Compare also Chakravarti and Perkin, *J. C. S.*, 1929, 193; Chakravarti, *J. Indian Chem. Soc.*, 1929, **6**, 214.

[5] Compare also McKenzie and Stewart, *J. C. S.*, 1935, 104, whose paper was published whilst this work was in progress.

[6] Ray and Robinson, *J. C. S.*, 1925, **127**, 740; Chakravarti and Perkin, *J. C. S.*, 1929, 127; Chakravarti and Swaminathan, *loc. cit.*

[7] Fritsch, *Annalen*, 1897, **295**, 359; Chakravarti, *J. Indian Chem. Soc.*, 1933, 693; Chakravarti and Swaminathan, *J. Indian Chem. Soc.*, 1934, **715**, 873.

Influence of Weather and Prices on the Cotton Crop of the Bombay Presidency.

ONE of the aims of the Agricultural Meteorology Branch, Meteorological Office, Poona, is to investigate statistical relationships between weather and crops. The cotton crop was taken up to begin with and the analysis has been completed for the Bombay Presidency which occupies nearly four million acres, about one-fourth of the total cotton acreage in India.

Cotton Tracts of the Bombay Presidency.—The cotton belt of the Presidency, excluding Sind, can be divided into four distinct tracts defined by the character of soil and season and consequently also by the type of cotton grown in them though they naturally grade off into one another. These tracts are:

(i) The South Gujarat with 30″—40″ of annual rainfall.
(ii) Karnatak with 20″—30″ of annual rainfall.
(iii) North Gujarat with 25″—30″ of annual rainfall.
(iv) Deccan Tract with 20″—30″ of annual rainfall.

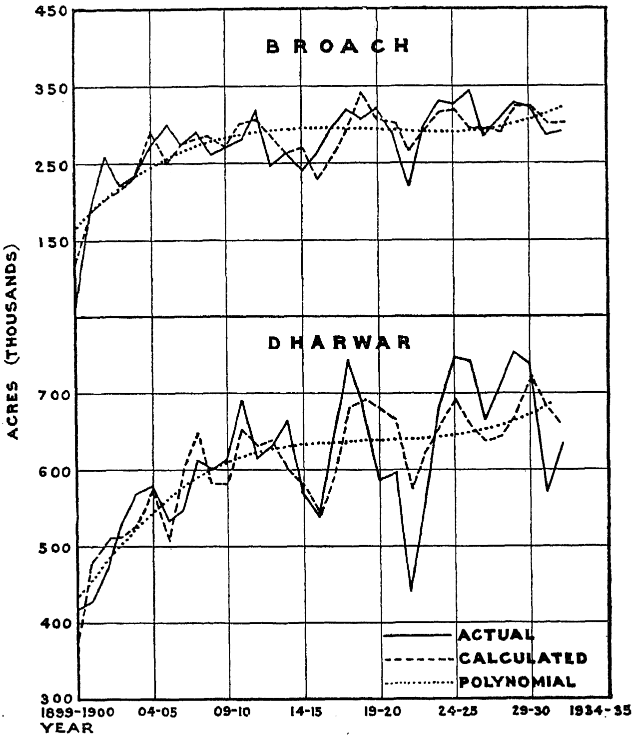
Sources of Data and their Limitations.—The figures of acreage, yield and price have been taken from the *Season and Crop Reports* of the Bombay Presidency and the meteorological data from the records of the India Meteorological Department. While the official statistics of area sown are fairly accurate, the data of yield per acre have certain limitations. The detailed examination in recent years of the official forecasts, the returns of cotton ginned and pressed, trade statistics, by the Indian Central Cotton Committee, has conclusively shown that the yield of cotton has in general been underestimated. It cannot be expected, therefore, that the statistical analysis of the "yield per acre" and weather factors would indicate anything more than certain general relationships.

Secular Changes and Variability.—The area and yield data for cotton of important districts of each of the above tracts have been examined. Some interesting results as regards the influence of weather on area and yield and also the effect of the prices of cotton on area sown have been obtained. Significant trends in the area, yield and prices have been noted in the data extending over a period of 43 years commencing from 1890. The mean acreage and its coefficient of variability are given for different districts in columns 2 and 3 of Table I below. It is interesting to observe that the area under cotton in Ahmednagar is very variable and seems to depend mostly on the timeliness of the early rains.

TABLE I.

District	Mean area sown (thousands of acres) 1890-1932	Coefficient of variability
Khandesh ..	1,229	8·2
Ahmednagar ..	116	54·5
Belgaum ..	206	23·1
Bijapur ..	500	30·0
Dharwar ..	567	12·9
Ahmedabad ..	328	29·2
Broach ..	269	14·9
Surat ..	134	15·5

Correlations of Area with Prices and Rainfall at the Time of Sowing.—Correlations of 'area' with 'prices and rainfall at the time of sowing' have been worked out for the above cotton-growing districts. Prices rather than rainfall seem to dominate the area sown to cotton in the Khandesh, Ahmedabad, Broach and Dharwar districts while in the Surat district both the



COTTON ACREAGE.

Fig. 1.

AREA.

Factors used.

(1) Broach District { Sowing—June, July. Harvesting—February, March.

June Rainfall and average price of Broach variety during the seven months January to July, prior to the sowing season.

(2) Dharwar District { Sowing—September. Harvesting—March, April.

September Rainfall and average price of Dharwar variety during the seven months January to July prior to sowing season.

Fig. 2.

AREA.

Factors used.

(1) Belgaum District

Sowing—August, September.

Harvesting—February, April.

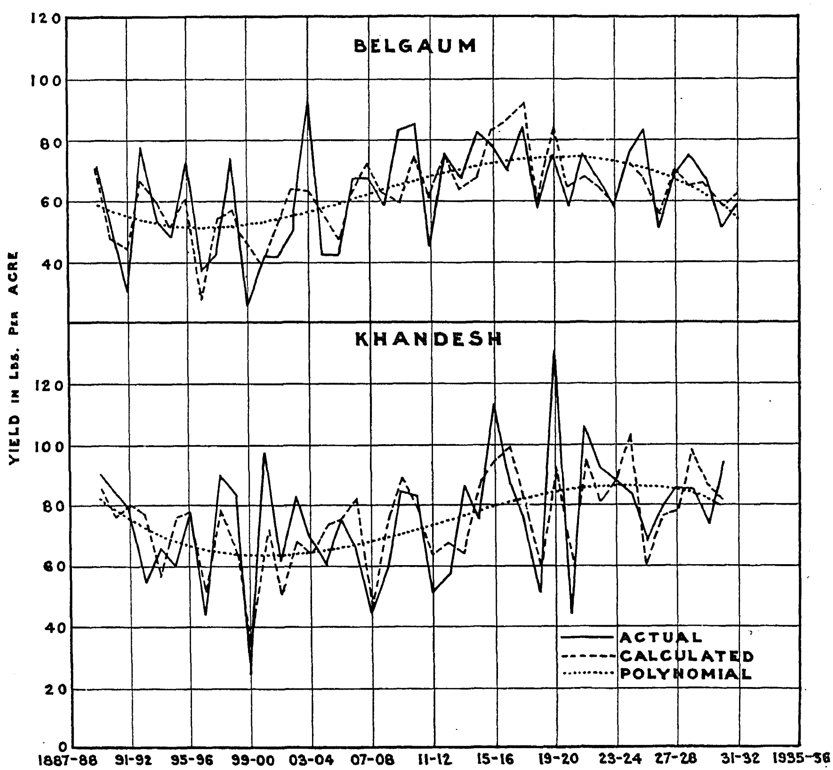
September and October Rainfall and October, November and December Maximum Temperatures.

(2) Khandesh District.

Sowing—June.

Harvesting—November, December.

July and September Rainfall and May, September, October and November Maximum Temperatures.



COTTON YIELDS.

rainfall and prices show significant correlations. In the districts of Ahmednagar, Belgaum and Bijapur significant correlations between area and rainfall at the sowing time are obtained while those between area and prices are insignificant. Formulæ have been worked out for calculating the cotton acreage from prices and rainfall at the time of sowing. Fig. 1 shows the actual and calculated acreages in the Broach and Dharwar districts for a period of 33 years.

Influence of Rainfall and Maximum Temperature on the Yield of Cotton.—The limitations of the yield statistics have already been referred to. Use has been made of the past data as available for studying the influence of weather factors on the yield of cotton. Significant correlations of rainfall and maximum temperature with cotton yields have been obtained for the cotton-growing districts. The actual and the calculated values for Belgaum and Khandesh are given in Fig. 2. The results will be discussed in greater detail elsewhere.

Investigations on other crops will be taken up.

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Agricultural Meteorology Branch,
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Poona,
December 11, 1935.

Cell Sap Acidity and the Incidence of White-Fly (*Bemesia gossypiperda*) on Cottons.

THE relationship between plant "condition" and insect attack is of considerable significance in crop production and crop improvement. Insects often show a preference for certain parts of their host or for certain of their hosts during particular seasons. The White-fly of cotton provides an excellent illustration of this phenomenon. It invariably lays most of its eggs on tender leaves on which, consequently, the nymphs feed. It shows partiality for different varieties of cotton, at different times. Early in the season, the indigenous varieties are more seriously infested but the relative infestation changes over from the indigenous to American types during July or August.

This behaviour most probably is mainly dependent upon some constitutional difference in the cell sap of the tender and "old" leaves of the host plants and changes in the chemical composition in the varieties during different parts of the year. Since the one easily measurable change in the sap is its reaction or pH value, investigations were undertaken during 1932 and 1933, to test this in the case of Mollisoni (indigenous) and 289 F. (exotic) types grown under identical conditions. To start with, the observations were made with the glass electrode which was later on replaced by the micro-antimony electrode devised by one of us (Puri).

Preliminary results have shown that the pH gradient from top to bottom varied with the age of the plants. Differences were not marked in the very early stage in growth but later on the pH increased as we proceeded from top to bottom. Towards maturity, however, these variations became erratic and the middle portion showed the highest pH. A mean of the pH values of all the leaves, therefore, was taken for comparative purposes. These gradients in pH have also been noted by other investigators. Gustafson[1] (1924) found higher pH in the upper leaves of Sunflower; Mukerji[2] (1928), on the other hand, found a lower pH in the uppermost leaves of *Mercurialis perennis*, and Haas[3] (1920) noted a higher pH in upper 3 inches of shoot in sweet clover.

The present investigation has shown, that, during 1932 pH values for 289 F. were, on an average, slightly lower than those of Mollisoni, till the end of June or beginning of July, then they equalised and were practically uniform till August after which Mollisoni again showed higher pH values. The relative incidence of White-fly attack corresponded with the trend of the pH curve indicating partiality towards higher pH values and, therefore, was suggestive of some correlation with the reaction in the plant juice. The infestation, however, was not affected immediately but there was noticed a certain amount of lag. The nymphs being fixed on the leaves naturally could not move, and moreover, it must take some time before the effect of the change in the pH values is felt by the insects feeding on the sap. During 1933, the White-fly attack in general was quite insignificant and the pH values were also relatively low.

A thorough investigation along these lines may show that the variation in pH might be responsible for immunity of varieties of plants and control seasonal outbursts of certain pests. If so, there will be abundant possibilities of preventing attack of sucking

insects by controlling the pH values of the cell sap through soil treatment, or evolution of varieties with pH outside the taste of an insect. The attention of workers in general agriculture, plant breeders, soil physicists, chemists and mycologists is drawn to this line of research.

M. AFZAL HUSAIN.
A. N. PURI.
K. N. TREHAN.

Agricultural College,
Lyallpur, Punjab,
November 20, 1935.

[1] Gustafson, F. G., *Amer. Jour. Bot.*, 1924, **11**, 1-6.

[2] Mukerji, S. K., *Proc. Linn. Soc.*, 1928, **140**, 3-5.

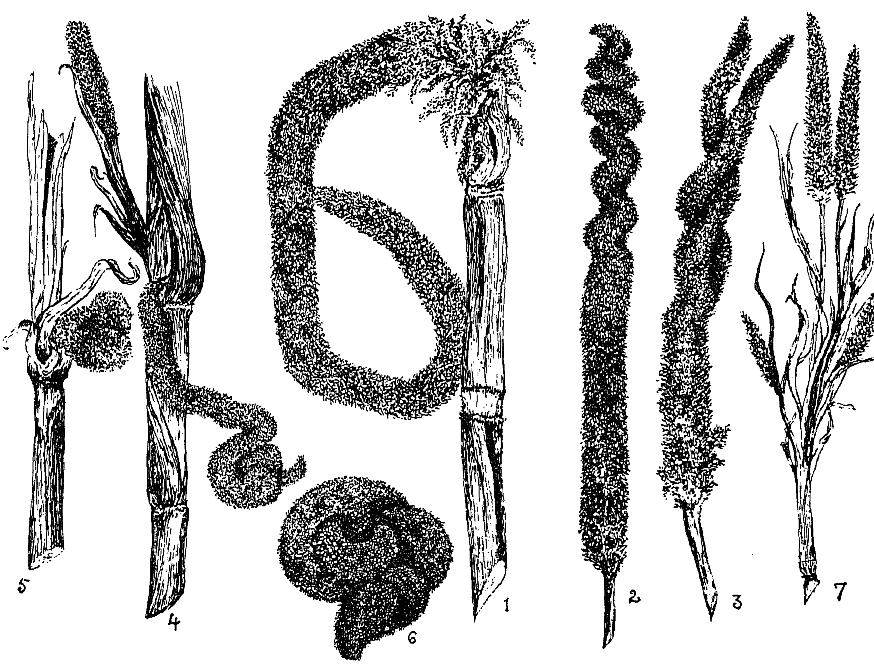
[3] Haas, A. R. C., *Soil Science*, 1920, **9**, 341.

Some Abnormalities of the African Pearl Millet.

RECENTLY through the propaganda made by Kunwar Sursinhaji, Director of Agriculture, Jamanagar State, Kathiawad, an African variety of *Pennisetum typhoides*, Stapf and Hubbard, *viz.*, the "Jamanagar Giant" producing an ear-head of six feet length was distributed and grown under experimental conditions in several parts of the Baroda State. Under local conditions the crop on the Baroda Agricultural Experimental Station and the surroundings was not able to produce the grain in spite of the profuse tillering—the factor of pollination being more or less interfered with. The "Jamanagar Giant" ear-heads resemble closely those figured by Rangaswami Ayyangar *et al*[1] and produce the same atavistic abnormal branching extending to an area up to six inches from the base.

Very often this basal branching was accompanied with the total bending of the ear-head (Fig. 1—1). Apical twining of the ear-head is represented in Fig. 1—2 and this twining is often associated with the bifid character of the ear (Fig. 1—3). Contortions, intricately interwoven, have been very common and the complicity may be witnessed from Figs. 1—4, 5, 6. Splitting or branching of the ear-heads which one comes across in local Bajri (Figs. 2—2, 3, 4) is also met with in "Jamanagar Giant" (Fig. 2–1) giving almost the form of fingers to the ear-head. Very typical basal branching along with leaf production is represented in number 5 of Fig. 2.

Branches from nodes on the same tiller were usual and two plants producing this branching with very simple and small types of ear-heads (Fig. 1—7) have been observed.



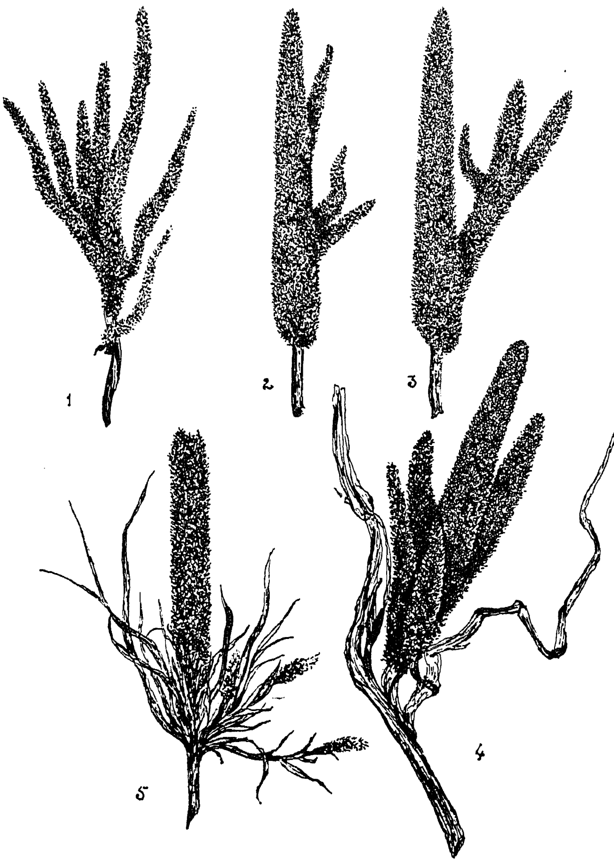


Fig. 2.

A few seeds from the latter are collected for further observations.

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R. S. PATIL.

Research Laboratory,
Agricultural Experiment Station,
Baroda,
November 29, 1935.

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1 *Curr. Sci.*, 1935, 4, 237-238.

Mortality of Fish of the Madras Coast in June 1935.

LARGE catches of fish, more or less in an exhausted condition, were made by the fishermen, on the Madras coast, in the month of June 1935. Numerous anemones, Cavernularias, Sipunculids, and countless Tetrodons and Diodons in various stages of growth were washed ashore. The papers reported that the sea-water was unusually muddy. Enquiry amongst the fishermen revealed the fact that the fish near the coast showed a tendency to swim near the surface, allowing of easy capture. Townet water collected at this time was almost of a soupy nature on account of the countless millions of *Noctiluca miliaris* present in the water, imparting a pink hue to the surface waters. The plankton showed also a large number of dead fish fry mostly belonging to the Scienidæ. Such fish mortality has been observed in previous years as well.

It is well known that there is a certain amount of variation in the temperature and the salinity of the coastal waters of Madras in the different parts of the year, and according to Sewell's charts,[1] the following are the figures for salinity per mille :—

September—November ..	30·00 to 32·00
December —February ..	33·25 to 33·50
March—May ..	33·50 to 33·50
June—August ..	34·00 to 34·50

The temperature of the sea-water and the air above is highest during May to June.

The amount of oxygen dissolved in the sea-water is known to be affected by changes in temperature and salinity.[2] It seems probable that the exhausted condition followed by the death of several marine animals, especially of the fish near the coast, during summer, is due to oxygen deficiency caused by the increase of temperature and salinity, heightened by the greater demand for oxygen by the animals owing to the higher rate of metabolism consequent on higher temperature. Further, the fall in the Diatom activity in the Madras coast about this period,[3] followed by an enormous increase of the Dinoflagellates, soon tends to use up the available oxygen, as a result of which many organisms suffer and get asphyxiated.[4] As the surface waters contain more of dissolved air, there is a tendency on the part of fish to come to the surface, with fatal results as their gills probably get choked up by the swarming Dinoflagellates. A similar observation of Dinoflagellates causing mortality of fish and other marine animals, has been recorded for the Calicut coast in September 1922, by Hornell and Ramaswami Naidu.[5] The sea current which at this time is towards the head of the Bay is probably another contributory cause, and many bottom forms get loosened and float up to the surface. Large numbers of bottom inhabiting Sipunculids were found floating, and this could be accounted for only by some such explanation as the one given above.

The mortality of the fish fry in particular is very considerable, and this is due to the fact that they are more easily affected by adverse conditions than grown-up fish. Wells[6] has conclusively shown for *Fundulus* that the increased oxygen requirements at higher temperatures are much greater for young fish than for adult forms.

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Research Laboratory,
Madras.

[1] Sewell, R. B. S., *Mem. As. Soc. Bengal*, 1929, **9**.
[2] Murray and Hjort, *Depths of the Ocean*, 1912.
[3] Menon, K. S., *Rec. Ind. Mus. Calcutta*, 1931.
[4] Mayer, *Carn. Inst. Washington*, Publ. 183, 1914.
[5] Hornell, J., and Ramaswami Naidu, M., *Madras Fisheries Bull.*, 1923, **17**.
[6] Wells, N. M., *Physiol. Zool.*, 1935.

Ancient Wheat and its Viability.

ON every occasion when any fresh archæological discovery is made, the votaries of ancient civilization lose no time for the glorification of achievements of the past. In some cases, praise is well deserved and based on substantial evidence, but in other cases much fantastic colour is given to the value of findings and ridiculous pretensions are made. One such instance that has come to the forefront, time and again, is that of the germination of Egyptian mummy wheat and recently of the wheat found in the excavations carried out at Mohenjodaro. In spite of conclusive evidence a great many people still believe that the ancient wheat of Egypt over 6,000 years old has been found to be capable of germination. In this connection, Bower[1] (1923) mentions that " A. de Candolle, after examining the evidence upto 1882, concluded that no grain taken from an ancient Egyptian Sarcophagus and sown by horticulturists has ever been known to germinate, nor is there any trustworthy evidence upto the present date." Buller[2] (1919) states that "It is still currently reported that this mummy wheat, after being sown, has been observed to germinate; but there is no truth whatever in this story. Careful experiment has demonstrated that all real mummy wheat has entirely lost its vitality."

The writer[3] had an opportunity to report as follows on the examination of some samples of cereals found at Mohenjodaro and kindly supplied by Rai Bahadur Daya Ram Sahni, Director-General of Archæology in India ;—

General.—The grains in all the three samples are completely carbonised. They have turned black both on the surface as well as inside and have the appearance of charred material. The surface is quite smooth as in fresh normal grains and both the proximal and distal ends are intact. The form and outline of the grain is very well preserved and they still possess their typical shape.

The embryo retains its form in some grains but in others it is disintegrated and a hollow is left.

The grains were tested for germination power but were not found to be viable at all. On being moistened with water the grains crumbled into powder forming fine black ash.

Sections of the grains did not show any cells.

Sample No. I.—L. 855 Room No. 11, 2 ft. B.S.L.

This is a sample of wheat grains and consists of two types, namely, (i) *Triticum sativum*, sub sp. vulgare (common wheat), and (ii) *Triticum sativum*, sub sp. compactum (Dwarf wheat). There is a greater proportion of the first type.

Measurements of the grains of the sample as compared with those of the present-day corresponding cultivated wheats are as follows :—

Length of grain vulgare type, present-day cultivated ..	0·57 cm.
Length of grain vulgare type, excavated sample	0·55 cm.
Length of compactum type, present-day cultivated	0·47 cm.
Length of compactum type, excavated sample	0·43 cm.

Sample II.—D. K. 10478 Room No. 0190, and

Sample III.—D. K. 11419 Room No. 0208–7·11 B.S.

Both these samples are of barley of the naked (huskless) variety *Hordeum vulgare* Linn., variety nudum. There appear to be two kinds of grain, one longer and narrower than the other.

Remarks.—Barley is stated to be one of the first cereals cultivated by man. Grains of barley have been discovered in Egypt belonging to pre-dynastic and early dynastic periods.

These samples are believed to have remained buried for about 4,000 years and are of later date than the Egyptian mummy wheat. In face of this evidence and the opinion of other authorities, stories about the ability of ancient wheats to germinate have to be received with caution. All

speculations about such old wheats being viable should be set at rest. In the course of some work that the writer has done on the duration of life of wheat, it has been clearly established that wheat grains when stored with usual precautions against the attack of insects lose germination power totally within 8–10 years.

JAI CHAND LUTHRA.

Agricultural College and
Research Institute,
Lyallpur,
December 9, 1935.

[1] Bower, F. O., "Botany of the Living Plant," 1923 Edition.
[2] Buller, A. H. R., "Essays on Wheat," 1919.
[3] Marshall, Sir John, "Mohenjodaro and the Indus Civilization," Vols. I & II.

A Biblio-Film Service.

THE direct result of the rise in prices of German periodicals and the imposition of an export duty on them by the Reich Government was the stoppage, by a majority of American libraries, from purchasing many of the German journals. In order to help scientific institutions in having access to these publications, however, the U. S. Department of Agriculture established in 1934 a laboratory for copying and distributing scientific papers and books on cine-films. Even though the price of German publications has now been reduced, the U. S. D. A. Biblio-Film Service seems to have become a permanent institution; for, a keen demand for other rare publications

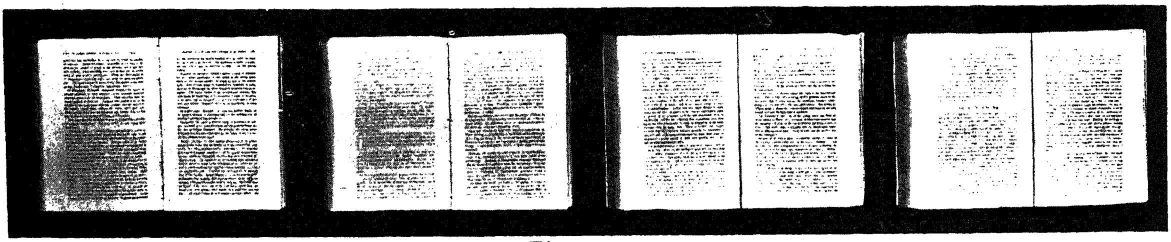


Fig. 1.

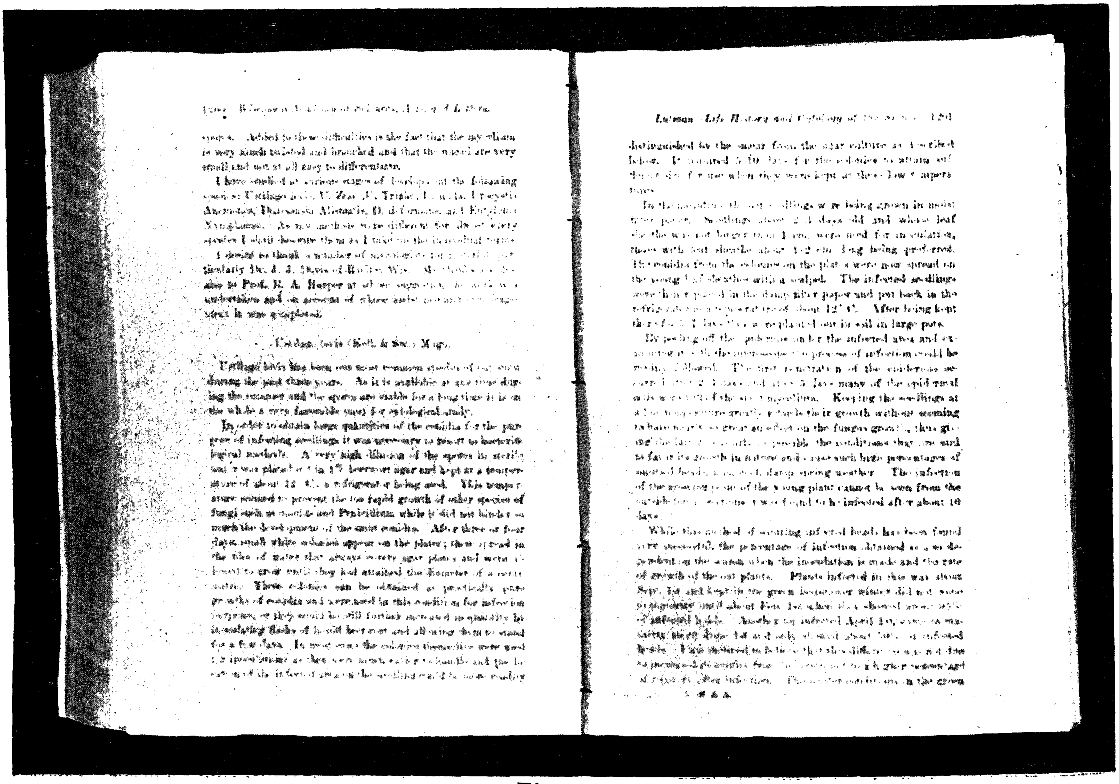


Fig. 2.

which can be easily obtained in this manner at a relatively small cost seem to have now arisen.

Recently the writer wished to consult a paper published in a rather rare journal. No reprint being available, a request was sent to the U. S. A. which brought a cine-film strip containing negatives of each of the 46 pages of the article at a cost of 35 cents (about a rupee). This strip can be inserted in a projector and read or prints can be made and read with a lens of low magnification. Enlargements can also be made which permit direct reading. Fig. 1 illustrates a print made from the film and Fig. 2 an enlargement, both made at Pusa.

B. B. MUNDKUR.

Imperial Institute of
Agricultural Research,
Pusa, Bihar,
January 6, 1936.

The Total Eclipse of the Moon.

THERE was a total eclipse of the Moon on the 8th January 1936. The circumstances of the eclipse was published, in advance, in the *Government Gazette*, dated the 24th December 1935. The phenomenon was observed

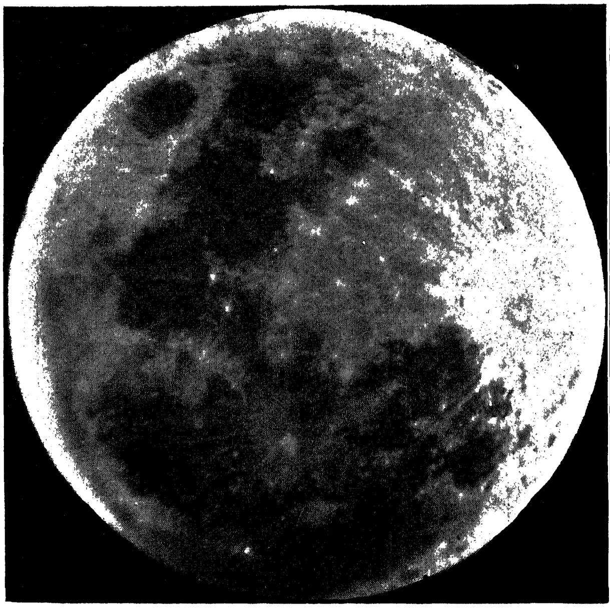


Fig. 1. Full Moon, 9 p.m.—Jan. 8th.

at the Trivandrum Observatory and photographs taken at different intervals. The commencement of the eclipse was observed to be at 9–36 P.M., and the totality began at 11–6 P.M. The duration of the totality was about 24 minutes and that between the first and the last contact of umbra was about 3 hrs. 22 minutes. As the sky was very

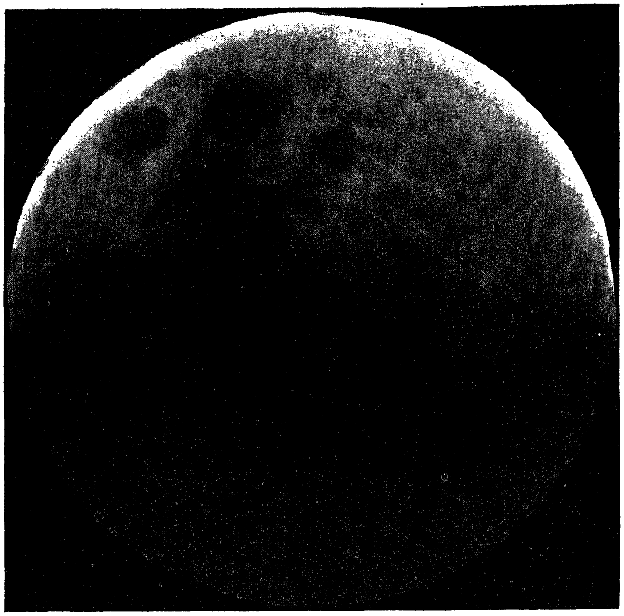


Fig. 2. 10 p.m.—Jan. 8th.

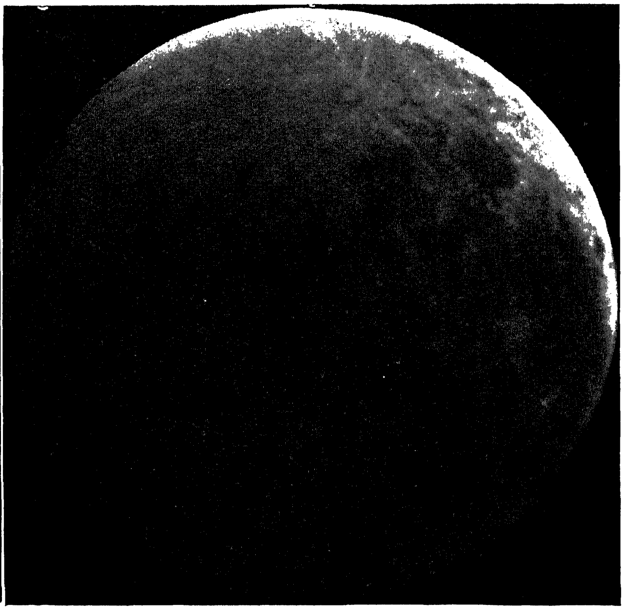


Fig. 3. 0-35 a.m.—Jan. 9th.

clear, the phenomenon could be observed conveniently throughout. Just before the commencement of the totality, the occultation of the star δ Gemini was also observed

through the telescope. During the time of totality the southern side of the Moon's disc was much brighter than the northern side, as the Moon passed through the southern half of the Earth's shadow.

H. SUBRAMANI AIYAR.
H. H. The Maharaja's Observatory,
Trivandrum,
January 11, 1936.

Energy and Economics.

IN *Current Science*, May 1935, appeared a valuable paper entitled "Energy and Economics" by Dr. Gilbert Fowler.

This comprehensive article deals with the fundamentals underlying production, *e.g.*, man-power, solar energy and other natural forces which have been harnessed for man's service. Dr. Fowler suggests a new unit he calls "the Ern" which might be employed as a universal unit measure for production. The Ern is based on the 10 gms. of Nitrogen (300 calories) which is required in the daily food ration of a man.

This paper because of its scientific approach to economics is unusual, and it appropriately appears in *Current Science*. Its publication perhaps indicates prophetic vision on the part of the Editorial Board for it is becoming apparent that production and distribution are essentially technical and scientific matters, and that any nation which produces goods has evolved immediately all the credit necessary to purchase and consume those goods. This is irrespective of any antiquated notion that the artificial financial system has the right to come forward and inform a state which has already produced the goods, that they must not or cannot eat or use those goods produced.

The time has long past when the scientists —*no matter of what calibre*— can afford to assert he has no time for economics. Economics and finance have never been a science and that is why they fail to handle the scientific facts of our modern stupendous production and the present age of plenty which applied science has evolved. Prof. Einstein on reaching New York some 2 years ago publicly announced there that "the production is available, it is merely a matter of arranging distribution". Prof. Soddy of Oxford has for many years ("Man *versus* Money," etc.) bitterly inveigled against a financial system which stultifies so outrageously the distribution of goods following the ever-increasing output rendered possible now by scientific research.

While it is obvious every one should concentrate upon his work, it is equally obvious every one should grasp at least the basic principles of finance, production and distribution or he will find he again has no work or reduced pay because of this common delusion that you can leave distribution to interested financiers. Adequate distribution is essentially *everybody's* job, especially every voter's job, or the distribution will not be carried out. There is a kind of wooden-headed conceit extant among science research men which also leads fine business men and primary and secondary producers to feel proud that they "wisely" leave finance and distribution to others—and then they wonder why the markets fail and salaries fall and bankruptcies occur. It is just this stupid attitude, encouraged by a well-controlled press, which international financiers, industrial monopolists and munition manufacturers rely upon, and it is responsible for the present internal and international strictures.

There is now a widespread appreciation by intelligent and unprejudiced people in Europe, America and Australia—that it is not production in this age of plenty, but the antiquated financial system which fails to liberate the purchasing power for consumption of this enormous production, which is responsible for the past five years of world crisis. Nowhere is this appreciation more apparent than in England, Canada, Australia and New Zealand. The United States of America has failed by deliberately going into further debt and its methods are therefore doomed to failure.

In May this year the British Science Guild (6, John St., London, W. C. 2) published a Shilling pamphlet which outlines clearly some twenty schemes put forward in England to remedy the present intolerable position, and this publication has already been mentioned in an Editorial Note in *Current Science*, p. 214, October 1935. Reading these various proposals, if one may venture opinions, the McMillan and Prof. Keynes Schemes are very orthodox and unpromising; the Basil Blackett and especially Prof. Soddy's proposals are distinct steps forward; the Douglas Social Credit proposals are more fundamental and give greater promise of prosperity and security, while the communist schemes are more vague and hardly immediately possible.

It is significant that Alberta in Canada has a Social Credit Party in power in

Parliament and proposes to test some Social Credit methods. It is to be hoped their attempt will not be frustrated by adverse pressure of financial interests at Ottawa and elsewhere. Douglas Social Credit proposals have the advantage that they can readily be constitutionally adopted by a single nation, they provide purchasing power without increased debt or inflation, automatically introduce just prices at ample profit and yet leave private enterprise and initiative still able to reap success and further profits. The scheme paves the way to increased production and consumption, gradually eliminates taxation, gives security to business men and primary producers against bankruptcy; everybody's savings are safeguarded and employment and security against poverty are secured. As I write this letter news comes that the recently elected New Zealand Parliament is pledged to introduce Douglas Social Credit methods.

In conclusion may I refer again to Dr. Fowler's stimulating paper? While agreeing with the value of a universal unit measure of production "the Ern," this is, in my opinion, perfectly valueless and with no prospect of application until the readjustment of the present financial system, that is, until finance has been brought into accord with the physical facts of modern production by constitutional parliamentary measures involving no hiatus in either primary or secondary industry.

W. B. GURNEY.

Department of Agriculture,
Sydney, N.S.W., Australia,
December 22, 1935.

Blood Groups of the Pre-Dravidians of the Wynad Plateau.

By A. Aiyappan, M.A., F.R.A.I.
(*Government Museum, Madras.*)

KAPPERS[1] and PARR[2] in their recent studies of the races of the Near East have demonstrated that "blood-typing data on an area controlled by anthropometric measurements give evidence that the blood-typing approach to the study of anthropology has value". The jungle tribes of South India have been known for a long time to be the representatives of an extremely primitive strain of *Homo sapiens*, closely allied to the Veddahs of Ceylon and to the aboriginals of Australia.[3] Recent investigations have shown that the strain represented in a comparatively pure condition by the jungle tribes is not a mere survival in racial cul-de-sacs, but also permeates the lower castes of the general populations of the plains.[4] The problems in view, therefore, in the present investigation were: (*i*) whether serological tests would support and supplement the physical anthropologists' findings regarding the affinity of the hill-tribes of South India with Australians and (*ii*) what serological relationship exists between the higher Hindu castes and the hill-tribes.

Pre-Dravidian, Veddoid and Nishadic have been used by various investigators as synonymous terms to describe the tribes and the racial strain referred to above. Since the first of these terms has gained great currency and is, in fact, the oldest in use, it is advisable to retain it in conformity with the usual biological convention in nomenclature.

Physically the Pre-Dravidians are a good example of an extremely generalised race. As in the Veddahs the infantile nature of the face strikes the attention of the observer first. The face is round with prominent cheek bones, broad nose, retreating chin, and exceedingly sparse facial hair in the males. Short in stature, they have a proportionately longer torso. A moderate degree of prognathism was present in about 79% of the sample taken of the Paniyans of Wynad—the tribe selected for investigation.

This tribe was selected as the starting point of the present study because they are more isolated and in a purer state than most other Pre-Dravidian tribes. Wynad is a bastion like highland thrust sea-ward by the Deccan plateau into Malabar from the plains of which it rises abruptly to a height of about three thousand feet. A thick belt of moist evergreen forest fences it off from Malabar and a thick zone of malaria-ridden bamboo jungle from Mysore. People from the plains have

[1] Kappers, C. U. Ariens, "Contributions to the anthropology of the Near East," 1930, Amsterdam.

[2] Parr, L. W., *American Journ. of Phys. Anth.*, 1931, **16**, 16.

[3] Haddon, A. C., "Races of Man," 1924, Cambridge.

[4] Guha, B. S., "Indian Census Report," 1935, **1**, part III-A.

been penetrating slowly into Wynad from the twelfth century A.D. onwards,[5] but they have not yet made a success of the venture numerically or biologically. Any large scale admixture with the Paniyans has not taken place because of the great sexual jealousy of the tribal code, the poor stamina of the penetrating people and their fear of and dependence on the Paniyan labour force which is extremely unmanageable. Until recently the Paniyans were a very wild people not hesitating to murder a man from the plains for the sake of a piece of white cotton cloth. Not long ago they were living in caves and rock shelters as some members of the tribe do even now in the deeper regions of the jungles. According to the recent census, they number in all 32,410 in the Wynad and adjoining taluks of Malabar.

It has to be pointed out at this stage that the Australians, Veddahs and Paniyans, in spite of the general resemblances that they bear to one another, are differentiated by several anatomical characteristics, especially of the face. The aboriginal Australian has none of the infantile features of the Paniyan and has a greater stature than either the Paniyan or the Veddah. The Australian is hairier than the two latter. The Paniyan is prognathous while the Veddah is orthognathous, the former has his superciliary ridges less prominent than the Veddah and the Australian. The Australian is more variable in skin colour than the Veddah and Paniyan who range about 27 of Von Luschan's scale.

We know nothing of the blood-typing of the Veddahs, so we have to leave them out in the following discussion of the serological affinities of the Australians and Pre-Dravidians.

Two hundred and fifty Paniyans belonging to three different settlements were "typed" by the open slide method using two or three drops of blood. The standard serum was supplied by the Haffkine Institute, Bombay, through Prof. Ruggles Gates, F.R.S., under whose direction this work was done.

The following are the data obtained :—

Percentages in groups				Race Index	Frequencies		
O	A	B	AB		p	q	r
20·00	60·40	7·60	10·00	4·11	4·68	0·85	4·47

[5] Richards, F. J., *Indian Antiquary*, 1932, **61**, 170-174, **195-197**.

The Australian has O 57%, A 38·5%, B 3·0 %, AB 1·5% and a racial index 8·8.[6] Comparison with the data for the Australians shows that the Paniyans bear no close resemblance to them, but both agree in having an extremely small percentage of B group. Von Eickstedt made an interesting suggestion that the Pre-Dravidians may be regarded as the Palæ-Europid type, a suggestion which the blood-group data support.[7] In a correlation table of the values of p and q for various races the Paniyans will be placed very near the Lapps and other peoples of Western Europe. The Paniyans differ from the Australians in having a much lower percentage of O (20 against 57 of the latter) which, according to the hypothesis of Snyder, is the most primitive group, A and B having arisen as subsequent mutations. Typing, however, a sample of 84 Central Australian natives Cleland found 38.1% O, and 61.9% A[8]. If further research confirms that bigger series than that tested by Cleland have also a similarly high percentage of A, then we shall be able to say that in spite of minor differences in physical characters, serologically the Paniyans and the Central Australians are closely linked.

Blood-group data support physical anthropology in distinguishing the Pre-Dravidians from the higher caste Hindus. The Mahrattas of Goa in the neighbourhood of the main Pre-Dravidian region are 29.25% O, 26.75% A, 34% B, and 10% AB.[9] They are, like the rest of the Hindus, typed, high in B. It may be possible that the non-tribal Hindu population is a mixture of the Pre-Dravidian with the very high percentage of A and another racial strain high in B. The 7·6% B in the Paniyans may have been introduced through miscegenation with the men of the plains which though of an imperceptible kind has been going on since the importation of large numbers of estate coolies from the plains.

[6] Ottenberg, R., *Nat. Hist.*, 1926, **26**, 80-84.

[7] Eickstedt Baron von, "Mysore Tribes and Castes," 1934, **1**, Bangalore.

[8] Gates, R. R., *J. R. Anth. Inst.*, **64**, 23-44.

[9] Correia, Lt.-Col. A. C. G. da S., "Les groupes-sanguins des Mahrattes de l'Inde Portugaise." Congrès International des sciences Anthropologiques et Ethnologiques, *Compte-rendu de la première Session, Londres*, 1934, pp. 86-87.

CONTENTS.

Presidential Address.

The Role of Science in the Recent Progress of Medicine.

By Sir U. N. Brahmachari, Kt., M.A., M.D., Ph.D., F.S.M.F., F.A.S.B.

IN the fitness of things the Indian Science Congress has been invited to hold one of its sessions in this historic place, thanks to the hospitality of its most enlightened ruler, His Highness Maharajadhiraj Raj Rajeshwar Sawai Shree Yeshwant Rao Holkar Bahadur, Maharaja of Indore. In the annals of Indian history, the Holkars hold an honoured place for their achievements in the field of arms and of peace.

In rising to address you at this annual meeting of your Congress, I feel I am hardly worthy to occupy an office which is associated with the names of those with whom I cannot compete in greatness. A few years ago, Lord Rutherford stated at a meeting of medical men that the hopes of the world rested upon their success and ever-growing usefulness. Aviation, wireless, and television have now been accomplished, but one thing still left to wish for, Lord Rutherford very truly remarked, was long life and health, and it was the medical profession with whom it lay to give that guerdon to humanity. For "Happiness lies, first of all, in health".

BIOCHEMISTRY.

As a matter of the most vital concern in nation-building, the problem of nutrition demands very careful consideration by statesmen and scientists alike, more so due to the fact, as has been recently observed, that a great part of the world's population is not consuming the necessary foodstuff. An eminent Swiss authority predicts the decay of civilization unless there is a fundamental revision of the people's diet.

It has been stated that the function of nutrition is probably the centre of medicine from a medical point of view, and that the proper dietary of man is a most important subject for the maintenance of health and prevention of disease. As has been observed by Hopkins, during the whole history the needs of nutrition and the kind and amount of food geographically available have played a great part in determining the destinies of races. It has been stated "tell me what you eat and I shall tell you what you are". "Man's place in future history will depend in no small degree on

the food he eats." Nutrition is one of the essential functions of life and its value cannot be too much emphasised.

Up to 20 years ago, the reign of calories was supreme in the field of nutrition, and it was held that if the proper amount of energy required for maintaining nutritional equilibrium could be worked out in terms of calories, then the last word would be said about the problem of nutrition. But it has now come to be recognised that certain substances that had eluded detection in the past, are indispensable in our dietary for the normal activity of the tissue cells and the prevention of certain diseased conditions. Further, the study of the problem of nutrition has increased in recent times from the quantitative to the qualitative standpoint, especially with respect to the proteins.

Though it was long known that diseases like beri-beri were due to deficiency in the food of certain substances of unknown chemical nature, it was Hopkins who made in 1912 the monumental discovery of the value of the "accessory food factors", or the "vitamines" as they were termed by Casimir Funk, in the maintenance of normal functional activity and growth. The progress of research upon the nature, distribution and functions of vitamins has been very intense in recent days. To attempt to summarise all that is known about them is beyond the limits of my lecture. The discovery of vitamins has led to the relief of a considerable amount of suffering and disablement that is particularly true in regard to rickets. Many of them are simple chemical substances and it is possible that each of them possesses a strict specificity in its action, though lack of more than one vitamin may be responsible for the causation of the complex phenomena manifested by disease.

The function of vitamins and the pathological lesions due to their deficiency are known to those among you, who are biochemists or who belong to the medical profession. I shall not discuss them here.

It is possible that the lack of vitamins does not play such an important part in the causation of disease as has been claimed by some observers and that the symptoms following a deficiency of certain vitamins may be attributed to a disturbance in the gastro-intestinal canal. It is realised to-day that the processes of digestion are much more complex than was hitherto thought. The secretion of the intrinsic factor is but a case in point. It is now known that vitamin B_1 deficiency is the cause of lack of appetite and defective movements in the alimentary canal. It requires but little imagination to conceive that these effects must have some fundamental cause and that they could lead to a number of abnormal sequelæ, such as, defective absorption, stasis and toxæmia, to mention a few.

The minimum amount of protein required for the dietary of man has been a matter of dispute for a long time. Originally found by Voit at 119 grms., it was afterwards raised by Atwater to 125 and subsequently lowered by Chittenden to 60. Sherman quotes it at about 44·4. It has now been recognised that the quest for a protein minimum is really an illusion, as it depends not on the quantity but on the kind of protein supplied. The work of Hopkins on the essential amino-acids in connection with nutrition has come into prominence in the present day. As has been pointed out by him, the food proteins which can be used with the greatest economy in the body are those which contain all the amino-acids in such relative proportions as will correspond most nearly with their proportion in the living tissues of the consumer. These are the proteins of so-called high biological value, constituting "the first class proteins". It has been observed that the average consumption of Cambridge under-graduates, those in training being excepted, is about 80 grms. of protein.

There are many problems that await fuller investigation by physiologists and biochemists in future before the perfect diet can be proclaimed. A food in order to be effective, must be ingested by a body both physically and psychically sound. It is possible to be well-nourished on the simplest of dietaries. Who can say for certain what is the optimum protein diet or the optimum intake of fat? What about the food of the Eskimos, the human carnivores of the world, who live for long periods on purely animal food? Hindhede has emphasized the superiority of the high fat, low protein diet of the Danish farmers over the high protein, low fat diet of the neighbouring Finlanders. But is this applicable to all mankind? There has been much talk about the energy value of different foods expressed in calories. But, as Cathcart has said, are not these

merely convenient units of measurement? How are we to explain the deleterious effects of "very high" cereal dietary and how are they corrected by "protective" foods, such as milk and leafy vegetables? Do the cereals contain any toxins, which are neutralised by a proportional quantity of the protective food? What definite information is available as to the body needs of the different kinds of vitamins? A further question is the problem of hypervitaminosis, as also the actual part played by vitamins, and any difference which may arise from taking synthetic or natural vitamins.

Nearly 90 years ago, Chevers taught that the dietary of the Hindus with a very moderate quantity of animal food was the fittest for a tropical climate. Thus he wrote, "It is certain, that the law-givers, who prescribed for the people of India a diet consisting mainly of vegetables and water, the lighter kinds of animal food, such as fish, pigeons and goat's flesh, being only occasionally introduced in moderate quantities, judged almost as physiologically as they could have done, had they studied at the feet of Liebig and Prout." Similarly in a discussion on the dietary of man, the meatless diet of some of the finest soldiers of His Majesty's Indian Army who fought in the last great World War was highly extolled. This is an interesting subject for research in the quest of minimum animal protein required for human consumption and the future may show that it may be influenced by climatic conditions. Recent researches of Berg tend to show that apart from the nature of proteins, there are other factors which determine the minimum quantity of protein necessary to preserve nitrogenous equilibrium, such as, the particular protein the subject is accustomed to taking and the ratio of inorganic bases to inorganic acids available to, or formed in the body of, the subject.

This brings me to the question of animal *versus* vegetable protein. Investigators of the present day hold that, in general, proteins of animal origin are superior to the vegetable proteins for the purposes of nutrition and that the testimony of human vegetarians is useless in determining the amount of animal protein requirement of man, because they were probably not vegetarians during the first part of their lives.

Are there first class fats? At present we know little about the nutritional value of different fats, but some work goes to show that certain fatty acids of the linoleinic series may be essential. It has been stated that the synthetic fat intarvin may be used by fasting persons of normal health without the development of acidosis. Do not these adumbrate the possibility of the existence of first class fats? Further work is also necessary to determine if there are essential carbohydrates.

In recent years there has been an advance in our knowledge of the importance of inorganic substances, especially minerals in our dietary. Many of these such as calcium and phosphorus are required for structural purposes and their deficiency gives rise to structural diseases. There are others which are required to be present in minute quantities in our dietary and which are perhaps concerned with the stimulation of the active processes in the tissues. These are copper, manganese and perhaps yet other undiscovered elements. Their deficiency is regarded to be responsible for certain forms of anæmia, though very recently this view has been doubted by some observers. The possibility of the existence of undiscovered mineral deficiency in disease is for the future to reveal, and may I suggest that certain obscure diseases of India, such as, infantile biliary cirrhosis of children may be investigated from this point of view.

Complicated are the inter-relations of the vitamins, the hormones and the mineral constituents of the tissues in the prevention of certain diseases. For instance, biochemistry has shown that a supply of iron, copper, vitamin C and thyroxin are the essential factors in the formation of erythrocytes and hæmoglobin, in addition to an active bone marrow. Deficiency of any of these may give rise to certain types of anæmia. A generous supply of calcium and phosphorus together with a liberal supply of vitamin D is essential for the perfect development of the bones and teeth of the child.

In recent times, studies in nutrition have been concerned chiefly with the maintenance of normal health and production of a rapid rate of growth. It has, however, been observed still more recently that prolongation of life associated with a retarded rate of growth has been noted in many divergent forms, such as, rats and

brook trout and that animals kept on a restricted food intake for long periods outlived by a wide margin those that were allowed to eat full from the time of weaning. The inverse relationship of the rate of growth and the time of onset of senility is also apparent from other investigations. Evans has noted that animals injected chronically with preparations containing growth hormone of the hypophysis show evidence of premature senility. On the other hand, Lee and Schaffer have shown that administration of the pituitary growth hormone results in retention of juvenile chemical characteristics by the tissues. Other clues for the study of these problems are furnished by the facts that thymus extracts greatly increase the rate of growth and maturity while pineal extract seems to retard growth. Wetzel in his work on "Motion of Growth" has shown that excessive rate of growth during infancy and childhood is associated with excess of wasteful heat production and that this may have grave consequences. It is apparent that some of the current tenets in the field of nutrition require reconsideration in an effort to determine the optimal rate of growth for each period in life.

PHYSIOLOGY.

Recent researches have thrown light on the mechanism of the fundamental reflex reaction for the protection of the animals and have shown how with the evolution of an anti-gravity mechanism and of extended movement, the brain stem has become evolved to take over this increased responsibility. Magnus has analysed the various nervous stimuli from the periphery which are concerned in this very delicately co-ordinated mechanism. The new data have completely revolutionised our conception of the nervous system, and signs and symptoms of disease which hitherto could not be properly understood have now become capable of analysis.

In more recent years Sherrington and his school have worked more exactly on the relation of the nervous system to responses produced when it is active. These fundamental studies will no doubt throw much light on the changes so often observed in disease. His researches have shown that the centripetal impulses do not pass straight through the spinal cord, but at certain stations in the cord they are transferred into an enduring excitatory state which may in turn set up fresh impulses yielding the reflex discharges.

Adrian's researches have also added greatly to our knowledge regarding the exact nature of the impulses which pass along nerves in different conditions. With a most admirable technique he has studied nerve impulse and its origin with highly profitable results. He has come to the conclusion that change of potential may be of fundamental importance in the activity of nerve cells. He has shown that damaged nerve fibres set up impulses at very high frequencies and these perhaps play a part in sensation of pain, though sometimes impulses in the smaller slowly conducting nerve fibres may also be concerned in the physical mechanism of pain. He has been able to observe the activity of a single nerve cell and has shown that human voluntary contractions are regulated in exactly the same way.

In Russia Pavlov and his school have elaborated the reflex reactions of the higher parts of the nervous system. Their results are capable of considerable application to many of the higher human activities.

A. V. Hill has studied the nerve impulses with exquisitely sensitive apparatus from the point of view of thermal phenomena accompanying it and it is becoming clear that the nerve impulse consists of a transmitted physico-chemical event, the whole cycle of event comprising activity and recovery in the nerve being supported by the energy derived from metabolic oxidative processes, associated with the cycle.

Further it is possible to conceive "the nervous impulse as a succession of transformation of chemical into electrical energy, and conversely—these transformations being necessary by the structure of the fibres".

Haldane and his pupils have continued their well-known work regarding the control of respiration. Carbon dioxide, formerly looked upon as a product of excretion, to be got rid of as soon as possible, has been shown by them to be an essential stimulus to respiration. This discovery has been of immense value in modern anæsthesia. Further it has been shown by Yandell Henderson of Yale University that carbon dioxide is also essential for the tone of the blood vessels. Dale and Evans have shown that carbon dioxide is essential for the activity of the vasomotor centre, just as it is responsible for the activity of the respiratory centres. Barcroft has

shown the principles by which oxygen is transported by the blood. As a result of the work of Haldane, Barcroft and their co-workers, it is now possible to deal with respiratory distress and failure by more scientific methods than what was possible in former days.

Areas such as the cerebral and pulmonary vessels which were once thought to have a poor vasomotor supply have now been found to be much better supplied than had hitherto been imagined.

With regard to the heart, the earlier studies of cardiac disturbances by Mackenzie have played an important part in advancing our knowledge regarding the physiology of the heart, and the work of Starling and of Lewis has placed much of it on a strict experimental basis in more recent times. A new interpretation of the electro-cardiogram in disease has been recently evolved.

The discovery of the function of the carotid sinus by Hering and its study by Heymans have been of great value to physiology and to pharmacology as well. By the recognition of the activity of this sinus and its possible variations one can now explain many of the differences in response which hitherto have been a great drawback in experimental work. In the nerve connection of this sinus and the effect of pressure on it lies, according to some observers, the explanation of sudden death under gas anæsthesia.

One of the most important new facts discovered in recent years regarding digestion is the relationship of the proper functioning of the stomach to the production of blood, and the subsequent application of this to the treatment of pernicious anæmia. This work had its origin in the physiological studies of Whipple on the normal regeneration of blood after hæmorrhage and administration of liver. Following the same line of research Minot and Murphy found that administration of fresh liver had a remarkable curative effect on pernicious anæmia. This led to the recent liver therapeutics for treatment of the disease.

The researches of Castle, however, connected the etiology of pernicious anæmia with defective gastric secretions. Recent experiments of Meulengracht have shown that pernicious anæmia in human beings may be due to atrophy and inactivity of that part of the stomach which comprises the pyloric-gland region and may be said to have localised the seat of origin of pernicious anæmia in human beings. Thus stomach preparations for the treatment of pernicious anæmia may with advantage be producible from the pyloric-gland region.

From a physiological point of view, these experiments give the pyloric glands a function. As we know, it has hitherto been difficult to ascribe such a function to the pyloric glands and the special pyloric-gland cells. Now it seems possible that the pyloric glands are the seat of special secretory function and secrete the substance Castle's "intrinsic factor" that is essential to the blood and the nervous system.

It has been held that the ductless glands are the "glands of our destiny" and that "these potent overlords of our bodies are dictators of our minds and personalities". It may be possible that the future may reveal that genius, intelligence, beauty, character, morality, and other human characteristics are dependent upon diverse combinations of the secretions of these bodies, just as their deficiency or excess may give rise to disease.

Insulin has completely changed the prospect of the treatment of diabetes. The discovery that parathyroid extract mobilises the calcium of the bones has revolutionised the treatment of diseases due to calcium derangement. Our knowledge of the interaction of endocrines has increased in recent times. I would just mention a remarkable fact that, as shown by Houssay and co-workers, there is no glycosuria when both the pituitary and the pancreas are removed, and further that the injection of extract of the anterior pituitary is followed by the appearance of glycosuria.

May I end this portion of my address by making a little more reference to the pituitary, which seems to have a multiplicity of functions? It may be regarded as the headquarters for the hormones or the chemical messengers which control most of the other endocrine glands and thereby probably almost every cell of the body. The chemistry of the pituitary is by no means closed and it may be that the most important discoveries in the pituitary chapter have yet to be written. It has been held that "the integration of the endocrine system is based on the influence of the diencephalon upon the anterior pituitary, which through complex hormones acts on the other endocrine glands, stimulating or inhibiting the production of simpler hormones in them. These hormones are closely related chemically

to other substances concerned in normal activities, such as, the growth of the embryo, the growth of bone and calcium metabolism, as well as abnormal activities such as malignant growths." Further, "in general we can see a division of labour between nervous and hormonal events, and accordingly between the respective regulators, the central nervous system, and the anterior pituitary lobe. The central nervous system regulates principally the specific, acute functions; therefore it also influences those neurogenic endocrine organs, the adrenal medulla and the posterior pituitary lobe, the hormones of which cause acute changes. The regulator of the non-neurogenic hormonal system, the anterior pituitary lobe, regulates mainly the development and state, and partly also the secretion, of the remaining endocrine organs, the hormones of which bring about longer lasting changes of the conditions of many other organs" (Lœwi).

GENETICS.

The account of Mendel's epoch-making experiments in his cloister garden, on the crossing of varieties of the common pea, somehow or other sank into oblivion for thirty-five years. But such was the potentiality of his work that, when rediscovered, it not only laid the foundation but also gave a new impetus to the study of the science of heredity. In recent times Mendel's theory of what were called by him *factors* (now known as *genes*) has received confirmation in the hands of Morgan and others. Their physical existence in the chromosomes has been proved and it is now known that the chromosomes are indeed the bearers of the hereditary units and that to their very reliable mechanism we owe the regular behaviour of the inheritance of characteristics from parents to children. Heredity is really a most remarkable phenomenon. The production, generation after generation, of offsprings identical in all but minor peculiarities with their parents is indeed one of the great mysteries of life, and it is by the orderly division of the chromosomes and their contained genes life can be maintained. It is becoming more and more established that "the general laws laid down by Mendel have as wide a validity for genetics as have Dalton's for chemistry".

The practical outcome of the application of the principles of genetics as demonstrated by the magnificent work in research laboratories such as those at Cambridge, Edinburgh, Aberystwyth and Aberdeen, has been of immense value in improving crops and live-stock. The boundless possibilities in heredity revealed by the science of genetics have placed great power in the hands of breeders of plants and animals and they can now tell with approximate accuracy what to expect from matings. This knowledge has revolutionised breeding in all directions, and resulted in the production of bigger and better plants and animals used for food, clothing or pleasure. In the course of time man may be able to replace the natural selection of more fertile mediocrity and the artificial sterility of high-grade parents by human selection and the artificial fertility of high-grade parents. Sooner or later the frequency of the latter would increase in geometrical progression and control and guide the qualities of mankind in any way it desires for the good of man. The future trend of creative evolution, including man's own destiny, depends on his response to the new knowledge and on his intelligent application of genetical discoveries, in the near as well as distant future (Hurst). Genetics aided by better environments may also be able to prevent the transmission of hereditary weakness and hereditary diseases, some of which are sex-linked. In this way it may lead to the production of better type of men, free from diseases of the mind and body that are propagated from father or mother to their children and thus the difficult task of medicine for averting or curing hereditary diseases or diathesis will be reduced to a minimum.

CHEMISTRY.

I begin with the recent contributions in therapeutics due to the application of chemistry. If I were to attempt to enumerate the various compounds that are brought every day to the notice of the medical profession in recent times, as hypnotics, anæsthetics, analgesics, antipyretics, antiseptics, or for other therapeutic purposes, then their number will be legion and my task may be impossible. I shall therefore refer briefly to a very few principal therapeutic chemicals of recent times.

How complicated is the mechanism of chemotherapy is shown by the fact that a slight alteration in the constitution of a compound may bring about a complete

change in its physiological properties. This is well exemplified in the preparation of the various amino-quinoline derivatives for anti-malarial purposes. A slight change in the constitution of these compounds leads to a complete disappearance of these properties. 6-amino-quinoline and 8-amino-quinoline have no action on paramœcia in strength of 1 : 4000. The introduction of OH into 8-amino-quinoline and quinoline-8-glycine-amide raises their toxic action on paramœcia to a remarkable degree and the methylation of 6-oxy-8-amino-quinoline by replacement of H of OH by CH_3 reduces its action on paramœcia to nil (Brahmachari and co-workers). Diethylmonosulphone is without hypnotic action, while both dimethyl-sulphonediethylmethane and the isomeric diethyl sulphonedimethylmethane (sulphonal) are strongly hypnotic.

There is no doubt that general anæsthetics have been conducive to the advance of all branches of medicine. "The medical sciences, physiology, pharmacology, pathology and bacteriology would have remained inaccurate and incomplete hand-maidens of medicine, had it not been made possible by the aid of anæsthesia to critically examine, corroborate or disprove the claims, hypotheses and tenets of workers of all types" (Stander).

I now pass on to certain aspects of chemistry in its application to a few protozoal diseases as revealed by recent researches.

The best known of trivalent organic arsenicals is salvarsan, for which the non-proprietary name arsphenamine is in common use in the British Empire and the United States. The drug is now generally used in the form of one of its two principal derivatives. The first of these is neo-arsphenamine, the second is sulph-arsphenamine. The first pentavalent organic arsenical used in the treatment of trypanosomiasis was atoxyl. An important derivative of atoxyl is tryparsamide. It has been found very successful in the treatment of trypanosomiasis. Other new therapeutic organic arsenicals include stovarsol, etharsanol, proparsanol and carbarsone.

The first and best known of the symmetrical urea group of trypanocidal drugs is Bayer 205 or germanin. In 1924 Fourneau and collaborators described the production of a symmetrical urea, which is now obtainable in France under the name Fourneau 309 (moranyl) and is identical with Bayer 205.

Schulemann and his colleagues succeeded in increasing the anti-malarial properties of methylene blue by replacing its short side chains by a longer chain. Investigation subsequently conducted with the quinoline nucleus led to the discovery of beprochin afterwards named plasmochine or plasmoquine. Similar experiments were made later with other heterocyclic nuclei including acridine and this led finally to the discovery of atebrin. These compounds are of great therapeutic value in certain forms of malaria. In Calcutta a number of amino-quinoline compounds are being synthesised under the speaker's direction and their anti-malarial properties tested. Some of them have already been reported to have a marked action upon paramœcia.

One of the most terrible of tropical diseases, so far as certain parts of India are concerned, is *kala-azar*. Antimony, which was once banned to such an extent that the graduates in medicine of the University of Heidelberg had to swear never to use it, has now been found to be its specific. By the introduction of organic antimonials in its treatment, the mortality of this disease has been reduced from 99% to about 1 or 2% in uncomplicated cases. The terrible nature of this disease in its epidemic form when it ravaged Bengal in the Seventies was well described by a contemporary writer as follows :—"The devastation of the epidemic has a very sad tale to tell. Countries that once smiled with peace, health and prosperity, have been turned into hot-beds of disease, misery, and death. Villages that once rang with the cheerful, merry tone of healthful infants, now resound with loud wailings and lamentations. Huts, which offered too little space for their occupants are left without a tenant. The skulls of human beings now strew the fields at every few yard's distance. The fell disease has mocked every human effort, and absorbed in its powerful grasp, day by day and inch by inch, every blessed spot which once used to be prized for its salubrity" (Roy).

The next step in the treatment of the disease was the introduction by the speaker of the intravenous administration of metallic antimony in a state of fine subdivision, which was attended with remarkable benefit. It was observed that when injected intravenously the particles of antimony are picked up by the same cells in the spleen as those that harbour the parasites of *kala-azar*,

that the two contending agents thus come in closest contact with each other in these tissue cells, and that the fight ends most remarkably in the complete destruction of the parasites in the speediest way.

The next further advance in the treatment of *kala-azar* was the introduction of certain organic compounds of antimony and the use of these compounds in *kala-azar* infection has been the subject of the speaker's research for many years. and in 1920 some of them were prepared for the first time in India in the Calcutta Campbell Hospital.

Early in 1921, the speaker discovered an urea antimony compound for the treatment of *kala-azar*. Its introduction and his other researches on antimonial compounds opened up a new vista in the treatment of the disease in India by means of therapeutic organic antimonials, just as the discovery of salvarsan led to the introduction of organic arsenicals in the treatment of spirochætal diseases. This urea compound was named "urea stibamine".

Dealing with the relationship between chemical structure and physiological properties one meets with a remarkable series of compounds in recent times having a common nucleus but possessing varied physiological properties. I mean the compounds having the condensed benzene ring system or phenanthrene, as well as, the reduced phenanthrene *plus* a fourth five-membered carbon ring or cholane. The cholane nucleus is found in bile acids, cholesterol and other sterols.

A structure of the cholane type is also found in the sex hormones which are responsible for the secondary sex characters of animals. These hormones are œstrone, luteosterone and the male testicular hormone or androsterone. They have close structural relationships with each other and with bile acids and cholesterol which probably contain their biological precursors.

The male sex hormone or androsterone has been artificially prepared. Friedmann has pointed out that the aromatic ring, corresponding to ring A of œstrin is not necessary for the development of the œstrogenetic effect as the benzene nucleus can be replaced by the furane ring, fural pyruvic acid being even more active than benzal-pyruvic acid. Recent experiments suggest the possibility of getting œstrogenetic activity in ring-free compounds by arranging the carbon atoms 13, 14, 8, 9 of œstrin in a suitable way.

Synthetic hydrocarbons containing the phenanthrene nucleus, such as dibenzanthracene, are found to possess carcinogenic properties. The cancer-producing action of certain tars is due to the presence of a hydrocarbon allied to dibenzanthracene. It has been synthesised and the powerful carcinogenic action of the pure substance has been confirmed. It is, perhaps, the most potent carcinogenic substance so far discovered.

The aglucones, that is, the non-sugar parts of digitoxin, strophanthin and several other closely related substances are allied to the sterols as they embody structures of four carbon rings. Bufotoxin has a constitution closely allied to those of the cardiac aglucones and possess a characteristic action on the heart similar to that of digitalis preparations. The phenanthrene nucleus is present in some of the most powerful alkaloids, such as morphine and codeine of the opium group, and the corydalis alkaloids and in colchicine.

All hormones of the secondary types contain benzene rings. In some cases the ring is a simple one as in thyroxin, pituitrin and adrenalin. In others it is a complicated one, the condensed phenanthrene ring. The Needhams and Waddington have observed the most remarkable phenomena that the chemical organiser or, as they call it, the evocator which determines certain developments of the embryo, belongs to the same group.

X-ray work on vitamin B_1, B_4 and C has been carried out in recent times and the structural formula of C as *l*-ascorbic acid has been established by a close collaboration of crystal analysis with the ordinary chemical methods.

The structure of carotene and vitamin A has also been established by X-ray analysis, as consisting of *cis*-polyene chain which is presumably the chain of polymerised rubber.

Vitamin B_1 possesses two ring systems, one a glyoxaline or pyrimidine and the other a pyrrole containing a substituted sulphur. It is not allied to flavins. Vitamin B_1 possesses anti-beriberi properties. The crystalline specimens of Jansen and Donath are, according to most recent observations, the pure vitamin itself with the admixture only of a small and variable amount of inactivated vitamin.

Vitamin B_2 is a complex, containing flavin and another factor, the absence of the latter and not of flavin being considered responsible for the symptoms of pellagra in rats. The flavin factor exerts a growth-promoting action. A substance identical with lacto-flavin of milk which is allied to vitamin B_2 has been isolated and synthesised. Examining the oxidation-reduction properties of flavin-cleavage products, Kuhn and Moruzzi were able to sum up the relationship of the flavin group by saying that the parent substance was a reductant; that combined with a ring system which contains a substituted amino group it produced a colour; that the addition of a carbohydrate side chain yielded a vitamin; and that the further addition of a protein group resulted in an enzyme (the yellow respiration ferment of Warburg).

Vitamin C is closely related to simpler carbohydrates and sugars. It is a keto-hexonic lactone.

Vitamin D can be artificially prepared from irradiation by ultra-violet rays. It has been isolated from irradiated ergosterol in a crystalline and apparently pure form, the crystalline compound being known as calciferol. The production of vitamin D by the irradiation of the sterols of the skin by ultra-violet rays of the sun is a most interesting chapter in the history of medicine, reconciling, as it does, the dispute whether rickets is due to a deficiency in the diet or want of proper sunlight.

The discovery of type specific carbohydrates are among the most remarkable triumphs of chemistry in recent times. It has been observed that a derivative of gum arabic possesses properties resembling those of the specific polysaccharides of one of the types of pneumococcus serum. The value of polysaccharides possessing immunological functions, and the knowledge of their composition, properties and structure must be of great value in medicine. The polysaccharides of the cholera bacilli and of B. dysenteriæ (Shiga) have been investigated.

Vernadsky has put forward a hypothesis that the living organisms possess a selective power between isotopes of an element. Among the plants, Loring and Druce have shown that in the potassium of potatoes isotope of atomic weight 41 predominates while in ordinary potassium the chief isotope is of atomic weight 39. In the case of man the future may reveal that isotopes of elements play an important part in the maintenance of health and that they may vary in disease.

Barnes has suggested that the polymerised molecules of water are of primary importance in physiological processes. The discovery of the hydrogen isotope (deuterium) of mass 2 and the isolation of quantities of "heavy water", containing this isotope have opened a new field in the physiology of water. Gortner considers that the water in the Medusa is as much "alive" as are the proteins, the fats, the lipides, or the carbohydrates. The water relations and different molecular forms of water in the living organism lie at the foundation of problems concerning both health and disease. It has been held by him and others that in lyophilic hydrosols and hydrogels the water may exist in two states, *i.e.*, in the state of free water which is characteristic of water in bulk and in the state of bound water which is characteristic of the lyophilic system, and that the equilibrium between free and bound water is undoubtedly of major importance in vital phenomena. Two hypotheses have been presented as to the possible nature of bound water: (1) an oriented adsorption of the water dipoles at the interface, and (2) an oriented adsorption of hydrogens and hydroxyl ions. The effect of the substitution of the deuterium form of hydrogen in place of ordinary hydrogen and of the isotopes of other elements into organic molecules may have in the future an important application in biochemistry and medicine.

PHYSICS.

The Electro-cardiogram is a valuable apparatus for studying certain diseases of the heart. A portable apparatus which can be taken to the patient's house and which is constructed on the principle of the string galvanometer is now available. Another portable Electro-cardiograph based on the principle of the valve-amplifier is also available. By means of a special Electro-cardiograph outfit, simultaneous records of a heart may be obtained in the wards of a hospital for purposes of research showing (1) heart sounds, (2) electro-cardiogram, and (3) carotid pulse by means of Hill's wire sphygmograph. An apparatus consisting of a Stethograph combined with an Electro-cardiograph is now available. The combined Electro-cardiograph Stethograph may prove a valuable aid in cardiology.

The Electro-cardiograph has shown that tracings taken of patients dying of various maladies can demonstrate that for some time after clinical death, some cardiac activity could be registered, the duration varying from six to twenty minutes. These observations show that in cases in which there is cardiac stand-still during anæsthesia or in the new born, resuscitation may be effected by timely cardiac injection or needle puncture. There may be other conditions that may be discovered in future in which the same may be possible.

It may just be mentioned here that a convenient new method of assay of vitamin B_1, based on electro-cardiographic measurements, has been recently described.

One of the most recent advances in biophysics is the discovery of some electrical phenomena in the human brain, which were originally studied by Berger and subsequently by Adrian and Matthews, the latter observers using the Matthews' Oscillograph constructed on the principle of a valve amplifier. The electrical changes consist of a rhythmic oscillation of potential with a frequency of about 10 per second appearing when the person experimented upon lies quietly with eyes closed and disappearing when his attention is fully occupied. Non-visual activities which demand the entire attention, *e.g.*, mental arithmetic, as well as sensory stimuli demanding the same, abolish the waves.

Berger considers that this "Berger rhythm" represents the normal activity of every part of the cortex of the brain while the experiments of Adrian and Matthews point to the conclusion that they arise from the activity of cortical cells in some parts of the optical lobe connected with vision.

CONCLUDING REMARKS.

Forecast.

From what I have stated, it is clear that the various sciences can be of great service to MEDICINE. Some of them have contributed very substantially to the relief of human suffering from disease. They can obtain valuable findings for the clinician in diseased conditions which may be helpful to him, but the responsibility finally rests with him as to how to act upon their findings. This shows the great importance of what is called to-day Clinical Science. Anatomy the science of structure of the body, physiology the science of function and the meeting ground of physics and chemistry in their application to problems of health and disease, and biochemistry the science concerned with the chemical processes underlying the activities of living matter, can be of great service to the clinician. In recent times, the need for increased application of physics and chemistry to medicine has grown with tremendous rapidity.

Sectional Addresses.

MATHEMATICS AND PHYSICS.

President : DR. T. ROYDS, D.SC., F.N.I.

SOME SOLAR PROBLEMS.

DR. ROYDS drew attention to some problems concerning the sun which have recently been under investigation at Kodaikanal. The first problem is concerned with the relation between prominences at the sun's limb and dark markings on the surface of the sun's disc. The different ways of deducing the height of dark markings agree in giving the same average height as for the prominences at the limb. It is concluded that the prominences and the dark markings are different aspects of the same solar phenomenon. At the limb we see its profile, and on the disc we see its projection. This phenomenon which is exhibited in the sun by the prominences and dark markings consists of a long line of flame, the length along the sun's surface being generally enormous compared to the height above the surface and to the width. The average width is about 7,000 miles, height 14,000 miles, but their length frequently extends to 400,000 miles or more.

The force which can support the sun's chromosphere to the great heights observed has long been a problem. Gas pressure could only support an atmosphere on the sun to a height of 60 miles whereas the chromosphere is observed to a height of 6,000 miles or more. Milne's theory of selective radiation pressure as the supporting force is the only theory which has been even partially successful. A theory of great simplicity, it has explained not only the great heights reached by ionised calcium but also how calcium prominences may be driven away from the sun's surface as is occasionally observed. The great difficulty of the theory is to explain the presence of hydrogen, helium and oxygen in the chromosphere when the radiation pressure on all three of them is insignificant. Photographs recently obtained at the Kodaikanal Observatory show that oxygen is a normal constituent of the chromosphere and is present in great abundance. Hydrogen, helium and oxygen are the three most abundant elements in the sun, and their presence in the chromosphere seems to show that abundance in the sun is the main criterion for presence in the chromosphere. Yet the

rôle of radiation pressure on ionised calcium is not insignificant, for it seems to be effective in raising the small fraction of calcium in the sun's composition at low levels to such heights as are only otherwise attainable in appreciable quantity by the abundant elements.

New ideas of the formation of absorption lines have led to work being begun in a large number of observatories on the study of the intensity of light within absorption lines of the sun's spectrum. These studies are intended to enable us to count the number of atoms in the atmospheres of the sun. Various technical difficulties are involved in the accurate photometry of spectrum lines. At the Kodaikanal Observatory, the photometry of some of the strongest lines in the sun's spectrum has been carried out for different points on the sun's disc. The lines studied are mainly those of calcium and of hydrogen. It is found that the equivalent widths of the lines of calcium and hydrogen diminish towards the limb of the sun notwithstanding the fact that near the limb the line of sight through the sun's atmosphere is greatly inclined to the sun's radius. This problem is related to the darkening of the sun's disc towards the limb. As a result of the measures made at Kodaikanal, the densities and pressures of the deeper portions of the sun's reversing layer have been deduced.

CHEMISTRY.

President : DR. P. C. GUHA, D.Sc., F.N.I.

RECENT DEVELOPMENTS IN THE CHEMISTRY OF BICYCLIC TERPENES.

THE address on recent developments in the Chemistry of bicyclic terpenes gives a review of the work of a small group of substances occurring in essential oils, covering, however, too vast a field to be satisfactorily compressed into a lucid address. Only the briefest reference being made to many complex aspects, the compilation may be difficult to follow by those not conversant with the particular field. Opening with a description of the bicyclic ring systems in general, he refers to 0 : 1 : 1 butane-2 : 3 : 4-tricarboxylic acid prepared by Beesley, Ingold and Thorpe in which two cyclopropane rings are fused together, to Zelinsky's bicyclo-0 : 2 : 2-hexane, to Huckel's and Rao's work on isomerism in decalin, and to Linstead's on stereochemistry of bicyclo-octane derivatives. Azulene is not, as stated in the address, a sesquiterpene hydrocarbon but has a formula $C_{15}H_{18}$. The claim of Khuda about four forms of 4-methyl-cyclohexane-1 carboxy-1-acetic acid appears doubtful in view of the investigations of Linstead, Desai and Hunter. The references at the end, if the textual errors are eliminated, should be of value to those who have inclination for work on these lines. The section closes with a reference to the ingenious preparation by Guha of *p*-bridged-diketo ester from ethyl disodio-succino-succinate and ethylene bromide (*Ind. Sci. Cong. Abs.*, 1935).

The parent hydrocarbon of the camphor group norbornylane has recently been synthesised by Komppa (*Annalen*, 1934, **512** 172). "With the exception of camphene, borneol, fenchyl alcohol, camphor and fenchone, practically all the other fundamental compounds from which an amazing number of complex substances are derived, have been obtained artificially in the laboratory and it is with them that we are mainly concerned." But it is doubtful if these numerous substances by many investigators have any other than laboratory interest and filling the pages of Beilstein. In quite a number of the synthesis referred to in this address the original methods of Perkin, described between 1885–1895, have been adapted, the yields of many of the products, however, being of a low order. The recent synthesis of endocamphene camphenic acid, *d*- and *l*-epicamphor, α-fenchene, fenchone, Balbiano's acid and isolaurolonic acid by Lipp, Bredt, Bardhan, Lapworth and Ruzicka are then alluded to. After a brief reference to Nametkin and Wagner rearrangements the reader is amidst the physiological action of camphor derivatives, an aspect unrelated to the rest of the address. Attention is then drawn to several isomeric santenols and santinic acids described in literature, to synthesis of santene from methyl-norcamphor by Diels, and of santene glycol by Ray.

The difficulties of work in the thujane series due to lack of crystalline derivatives, racemisation, isomerisation are referred to, as deduced from the work of Kondakow, Henderson, Zelinski and Paolini. Simonsen's work on carenes, his recent synthesis of *cis*-homocaronic acid, Ebel and Mangelli's synthesis of norcarane and synthesis of Guha and Ghosh in this series have been alluded to. α-pinene is widely distributed in nature though it may not be right to say that β-pinene is just as abundant. Reference is made to the work of earlier investigators like Wagner and Tiemann in this group and more recent work of Komppa, Lipp and Ruzicka on synthesis of pinenes, pinocamphone and nitrosopinene. Kerr's synthesis of norpinic acid is then described and reference made to other methods. There have been numerous recipes for norpinic acid since 1890 but in the interest of future workers who may want a small specimen of synthetic acid it may be desirable to state that the only method which gives it, so far, is Kerr's method. Under one of the sub-titles in the address, "Natural hydrocarbons obtained artificially" one looks in vain for such an example; the homologues of pinene do not occur in nature. After alluding to failures to form a cyclobutane ring in a cyclohexane derivative by internal bridging, reference is made to the synthesis of keto-nopinone in support of which one would as well await more evidence. The important degradation products of pinene are then touched upon and it is said that

> "The experiment of Schmidt is of great importance as contrary to the statement of Simonsen, it proves the presence of the cyclobutane ring in β-pinene. By ozonising β-pinene he obtained nopinone and another product $C_{10}H_{16}O_2$ which on oxidation with permanganate gave pinonic acid."

Simonsen (*Terpenes*, **2**, 169) states there is no direct evidence of the presence of a cyclobutane ring in nopinone since neither nopinone nor β-pinene yield any acids of the pinic acid series. Schmidt obtained in his experiments mainly nopinone and small quantities of pinonic acid and its aldehyde. The latter were obviously formed from α-pinene contaminating Schmidt's

β-pinene. Schmidt's experiment does not appear to have been properly understood and it does not affect the contention of Simonsen.

Attention is drawn here and there in the course of the address to gaps in work which may be suggestive to investigators who have to be grateful to the President for this excellent review.

GEOLOGY AND GEOGRAPHY.

President: MR. B. RAMA RAO, M.A., D.I.C., F.G.S.

RECENT INVESTIGATIONS ON THE ARCHAEAN COMPLEX OF MYSORE.

EVER since the startling inferences of the Mysore Geological Survey were voiced in 1916, by Dr. W. F. Smeeth regarding (1) the igneous origin of the types of which the Dharwar schists are composed and the autoclastic nature of most of its conglomerates, (2) the intrusive relationship of the granitic gneisses towards the schists and (3) the absence of the basement rock on which they could have been formed, later discussions on the Archæan rocks of Peninsular India have mainly centred round these contentions. The Presidential Address of Mr. B. Rama Rao (Director of the Mysore Geological Survey) deals with these and other controversial problems of the Archæan Complex in the light of later investigations of the Mysore Geological Survey.

Structural characteristics of shallow water facies of sedimentation like current bedding, ripple marks and rain prints have been recently discovered in some of the exposures of quartzites of widely separated areas, and the results of chemical analyses of the associated phyllitic and micaceous schists and the highly altered types like cordierite, sillimanite gneisses and kyanite graphite schist indicate likewise a sedimentary origin. In the case of limestones and the banded ferruginous quartzites, the evidences are not always clear, but their intimate association with other recognisable sediments and the occasionally preserved relics of signs of original stratification are suggestive of *their* aqueous origin also.

With the recognition of distinct horizons of these different sediments, the Dharwar schists of Mysore can be classified into three series, not so much on lithological grounds, but on recognisable stratigraphic breaks as indicated by two well-defined sets of basal conglomerates. The lowest series consists mainly of igneous material—acid and basic intrusives, deformed lava flows and ashes. The other two series consist largely of sediments with intercalated beds of ashes, tuffs and flows. In the northern parts of the State these three divisions are noticeable, but as the belts of schists are traced southwards, the uppermost division disappears, and the lower two are found considerably cut up and often scattered as stringers of altered schists in the gneissic complex.

One of the common constituents of all these divisions is the banded ferruginous quartzite. The mode of origin of the type of the lower division is not clear, perhaps it is a case of silicification and replacement of a minutely fissured pyriteferous chert or felsite. The banded hæmatite quartzites of the middle division have originated as chemical precipitates while the ferruginous rocks of the upper division form typical products of sedimentation produced by the disintegration of the older members. Many of the ferruginous quartzite bands of Mysore are found to be of the middle division, those of the other two being of very small areal extent.

In correlating the Mysore facies of the Dharwar schists with other Dharwarian rocks of the Peninsular India on purely lithological grounds, such as the occurrence of the ferruginous quartzites or some dark hornblendic schists, the precise mode of origin of the types and their position with reference to the granitic rocks will have to be taken into consideration. There has been as yet no consensus of opinion on the correlation of the Dharwarian rocks of different parts and to formulate any authoritative statement on the subject, it is desirable that the various tracts of the "Dharwar schists" of Peninsular India should be examined conjointly by a selected committee of geologists having special experience of the regions they represent.

Recent investigations on the granitic complex of Mysore, disclose only *two* different periods of eruptive epochs and not four as till now believed. The older of these two granitic series has intruded subsequent to the Middle division of the Dharwar schists of Mysore, but before the upper division rocks were formed, and the younger series has intruded long after the entire period of the Dharwars.

The terms "Champion gneiss" and "Peninsular gneiss" as hitherto adopted by the Mysore Geological Survey stand in need of modification. In the former are found included unrelated rock types of different periods of formation all characterised by the accidental occurrence of blebs of opalescent quartz. The various types of granitic rocks which have been differentiated till now as of the series of "Champion gneiss" and of the "Peninsular gneiss" are found to be the modified products of consolidation of a single eruptive magma. Magmatic stoping has played a large part in the process of emplacement, and the incorporation and disruption of such stoped out blocks, combined with varying extents of their assimilation, have given rise to numerous types of granitoid gneisses. The term "Champion gneiss" is proposed to be retained for distinctly intrusive granites of the older series, and "Peninsular gneiss" as a descriptive term for the large areas of gneissic complex, the character of which requires further closer investigations. It is believed that parts of the basement on which the Dharwar schists had been formed might be existing as unrecognised islands in this complex.

The granulitic hypersthene rocks of Mysore, comparable in character to the Charnockites of Southern India are found to have resulted by the metamorphism, under varying conditions, of several unrelated rock types, all of them being older than the granitic intrusives. They do not form in Mysore any related series of differentiated phases of a normal eruptive rock, intrusive into the granitic gneisses, as is believed to be the case with the Charnockites.

These recent conclusions, naturally, require further verification and owing to the different orientations they would give to the general interpretation of the geological history of the gneissic complex of Peninsular India, it is hoped that the problems will be critically investigated in greater detail both in Mysore and in the rest of the Archæan tracts of Peninsular India.

BOTANY.

President : DR. S. R. BOSE, PH.D., F.R.S.E., F.N.I.

BENGAL *POLYPORACEÆ*.

IN his Presidential Address on Bengal *Polyporaceæ* Dr. S. R. Bose has dealt with the various aspects of *Polyporaceæ* he has studied in the course of last twenty years, for instance, he has discussed the importance and origin of fungi, has recorded the previous history of Bengal *Polyporaceæ* which is really a record of scrappy work done at irregular intervals. He has dealt with geographical distribution of Bengal *Polyporaceæ*, the conditions for their development in Bengal, the general nature of the soil of Bengal, the Fossil records of *Polyporaceæ*, their morphology and systematics, the anatomy as the basis of recent classification, their general structure, nutrition, cytology of reproduction and the chemical nature of fruit body of *Ganoderma lucidum*, their biological peculiarities, their physiology and medicinal properties and other uses.

Under the geographical distribution he has noted that when climatic conditions such as temperature, rainfall, humidity, etc., are analogous, it is astonishing to find the repetition of the species in very distant parts of the globe. Recently in 1935 he has recorded the occurrence in the high hills of Lokra (Assam) in Bengal 8,000 to 10,000 ft. elevation of six European *Polypores* (*P. squamosus*, *P. sulphureus*, *P. gilvus forma licnoides*, *Fomes fomentarius*, *F. pinicola*, *Amaroderma rugosus*), which are never found in the plains of Bengal. This is probably because most of the plants of the high hills harbouring these species of *Polypores* as parasites or saprophytes do not grow in the plains.

Prof. Bose is of the opinion that for the establishment of stable classification of *Polyporaceæ* morphological studies should be supplemented by detailed study of anatomical, cytological, cultural, physiological, and biological, chemical and other characters, and that the old classification, however imperfect, should not be changed till we have accumulated data from the completed study of these diverse aspects of *Polyporaceæ*.

In connection with cytology-study it was found that the tramal hyphæ and the basidia were regularly bi-nucleate, two nuclei in the basidium coming into contact with each other gradually fused into one large fusion-nucleus with two prominent nucleoli. The process of nuclear fusion in the basidium of *Polypores* followed by two quick divisions (usually first meiosis and then mitosis) is regarded as a very much simpler type of fertilisation prevalent in the higher fungi; this process of nuclear divisions corresponds fundamentally to meiosis in higher plants. The chromosomes here are extraordinarily small, they could not be satisfactorily counted. According to the author the vacuolar bodies in basidia of *Polypores* correspond to Golgi-bodies so often described by Gatenby in animal cells and that the solid Golgi-elements are nothing but artifacts due to the excessive precipitation of metallic silver or osmium inside the vacuoles.

The chemical analysis of the fruit-body of *Ganoderma lucidus* with a strongly laccate upper surface shows that it contains resin, ergoster, ergosterin, fatty acids, mannite, some polysaccharides and voluminous deep-brown amorphous substance much resembling humus acid. The study of biological peculiarities of *Polypores* shows that mostly as saprophytes or parasites some species grow singly on logs or trunks and branches of forest-trees, while others have a gregarious habit. The decays in wood according to the gross characters of the rot are known as *white rots* and *brown rots*, depending on the colour; in the former case the wood becomes lighter in colour and in the latter it acquires a dark-brown or reddish tinge. Some species have corky or leathery fruit-bodies; others have hairy or soft and velvety upper surface. As soon as the rains begin to appear, they set forth in an advancing zone which is quite marked off from the old zone. Some *Polypores* begin their lives as saprophytes, attacking dead roots, stumps and branches, they then extend their hyphæ round the living cells in the adjoining portions and thus become converted into parasites. Others begin their lives as parasites, their spores usually entering through a wound, then they kill the living portion and finally establish themselves as saprophytes with a number of sporophores on dead parts of the plants. In extreme cases the whole central cylinder (heartwood) is destroyed, converting the tree into hollow structure. Some again rarely continue their activity after the tree has been cut and converted into timber.

Interesting studies on spore-discharge from dried fruit-bodies of *Polypores* have been carried out, only those that have basidia revive under the moist condition and shed spores after varying periods of desiccation (weeks, months or years), specimens without basidia never shed spores. Brown and coloured *Polypores* do not survive desiccation long, when detached from the host; they shed spores only for a short time in the fresh condition. Recently the author has reported that in specimens of *Ganoderma lucidus* and *Ganoderma applanatus* the basidia are succeeded after the rains by hyphæ projecting direct from the trama and bearing secondary spores at their tips, which are indistinguishable from the ordinary basidiospores in any way; probably these carry on spore-discharge in the dry season. It is a matter for future investigation whether the basidia themselves are transformed into such tramal hyphæ projections. There are a few instances where there was copious spore-discharge though not a single basidium was visible under the microscope, probably in the cases the tramal hyphæ projections carried on the spore-discharge. In November 1935, the author observed that after an unexpected shower of rain specimens of *Ganoderma* which had their basidia almost replaced by direct tramal hyphæ, reverted to basidia-formation.

Complete life-history studies of about a dozen local *Polypores* from spore-germination to the final fructifying stage have been carried out, the details have been published in the *Journal of Linnean Society* in 1930. It is found that these *Polypores* can fruit on a wide range of media irrespective of their special host. No special decoction is necessary for their spore-formation, almost all of them fruited in malt-extract-agar medium.

Recent studies on the determination of sexual reactions of *Polypores* by means of monosporous cultures show that most of them are heterothallic

and are potentially bisexual. This theory of potential bisexuality, first put forward by Ames in 1932, seems to cover most of the facts in various groups of fungi, though in two local *Polypores* the author has shown two sexes are of a comparatively stable character and not easily interchangeable according to the varying conditions, as is the case with various groups of lower fungi examined by different workers from time to time.

From the enzyme study of some local *Polypores* it appears that in each case there is a marked decline in the activity of enzymes as the fungus passes from purely vegetative state to the fruiting condition, that in the fruits formed in nature the activity becomes still less (but in the case of catalase slight increase of activity in the fruiting stage in artificial cultures has been noticed) and that extracellular enzymes are much more active than intracellular ones. The enzymes of the following groups were found:—(*a*) carbohydrate-splitting, (*b*) proteolytic, (*c*) lipolytic, and (*d*) oxidising enzymes. It is well known that secretion of enzymes varies qualitatively and quantitatively according to the nature of the medium of the fungus, having used malt-extract medium in all these cases the predominance of carbohydrate splitting enzymes was noted.

ZOOLOGY.

President : DR. H. K. MOOKERJEE, D.Sc. (Lond.), D.I.C.

THE DEVELOPMENT OF THE VERTEBRAL COLUMN AND ITS BEARING ON THE STUDY OF ORGANIC EVOLUTION.

PROF. H. K. MOOKERJEE of the Calcutta University dwelt, in his Presidential Address in the Zoology Section of the Indian Science Congress on "The development of the vertebral column and its bearing on the study of organic evolution". He said, evidences furnished by palæontology are imperfect owing to gaps in our knowledge of extinct forms. The theory of recapitulation is a real help in the matter of tracing the lines of descent where morphology fails. Hence, embryology rises greatly in interest in the study of the theory of evolution which means descent with modifications. Prof. Mookerjee has chosen in his address the development of the vertebral column as the latter offers a stable character of great morphological value in tracing the lines of ancestry of the vertebrates. The subject has been treated by him under the following heads :—

1. Formation of the centrum.
2. Formation of the arches.
3. Formation of the rib and the rib-bearing process.
4. Formation of articulations.

The late Prof. Hans Gadow classified the vertebræ according to the mode of formation of the centrum. His divisions are :—

1. *Chordacentrous.*—The sheaths of the notochord become the centrum by the migratory mesoblastic cells that get inside at the base of each arch which ultimately chondrifies as in Elasmobranchs.

2. *Archocentrous.*—The arches play an important rôle in the formation of the centrum. There are three sub-divisions of this :—

(*a*) *Pseudocentrous.*—Four pairs of arculia, *viz.*, *basidorsalia*, *basiventralia*, *interdorsalia* and *interventralia*, take part in the formation of the vertebral centrum, as in the caudal vertebræ of Urodela.

(*b*) *Notocentrous.*—The centrum is formed by *basidorsalia*, *interdorsalia* and *basiventralia*, as in the trunk vertebræ of Anura.

(i) *Epichordal.* The *basiventralia* are suppressed ; examples of this can be found in *Xenopus*, *Bombinator*, etc.

(ii) *Perichordal.* The *basiventralia* take part in the formation of the centrum as in the trunk vertebræ of common frog.

(*c*) *Gastrocentrous.*—Here the *basidorsalia*, *interventralia* and *basiventralia* are present. But the centrum is formed mainly from the *interventralia*, as in *Amniota* (Fig. 1).

If the theory of gradual evolution be held as true, such a wide range of diversity in the formation of the vertebral centra as outlined above by Gadow is rather difficult to correlate and explain, specially when it is well known that there is nothing more rigid and non-plastic than the skeletal system in the animal kingdom, and as the origin of this structure in the animal kingdom by mutation is problematic.

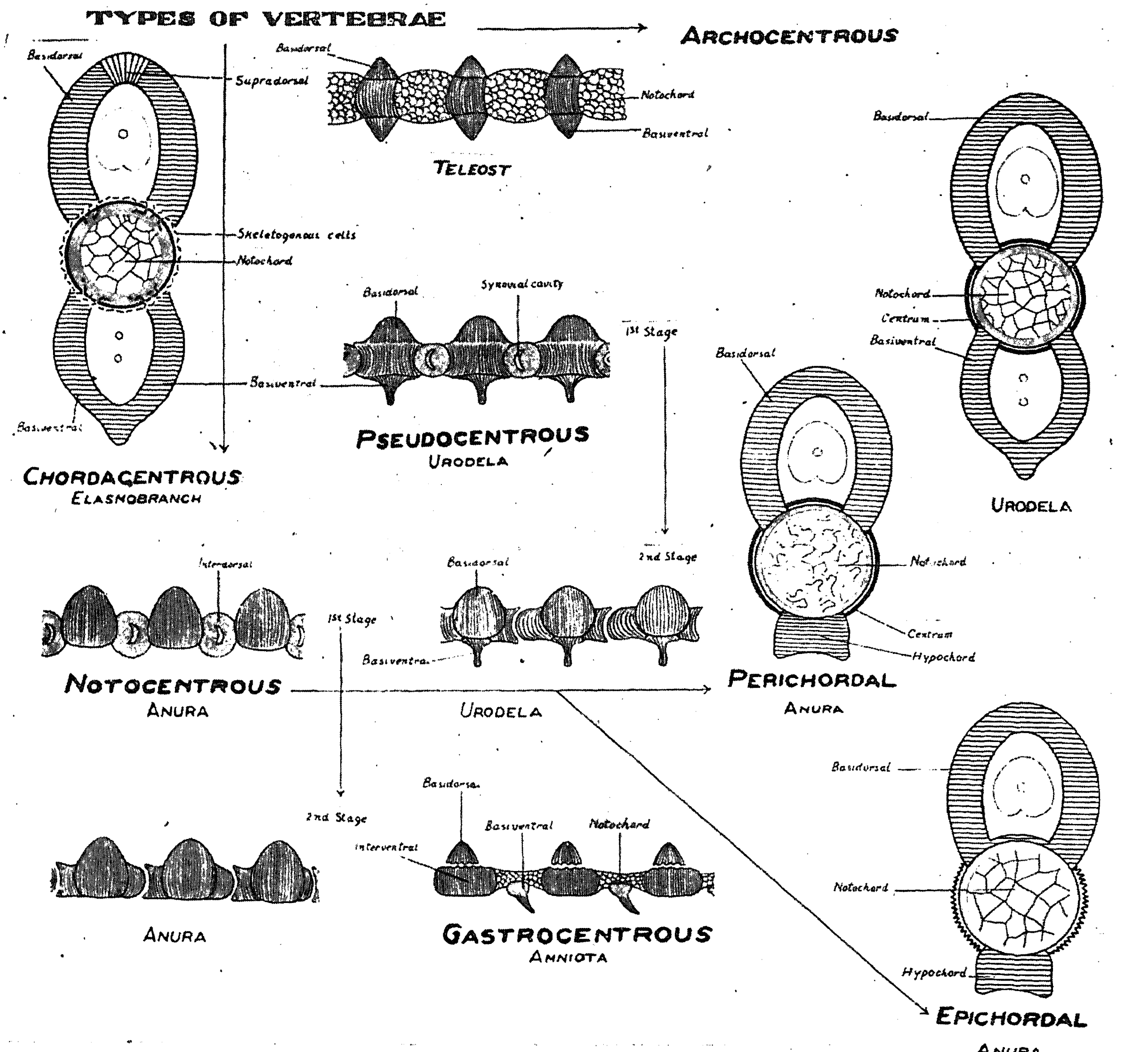
Prof. Mookerjee in studying the modes of development of the centra of the vertebral column has taken a series of microscopical sections of numerous fishes, frogs, lizards, snakes, tortoises, birds, moles, etc. He has shown that the centra in different classes have not been evolved independent of each other, as suggested in the various theories put forth by the previous authors, but that all the vertebrates have followed the same course of development and exhibit a gradual evolution from one end of the series to the other.

According to Prof. Mookerjee, in all vertebrata, after the formation of notochord and its sheaths the skeletogenous cells aggregate round the notochordal sheaths, forming an outer jacket known as the perichordal tube. In all the vertebrates, except in Elasmobranch, the perichordal tube alone gives rise to the formation of the centrum. In Elasmobranch the centrum is formed by the chondrification of the inner sheath with the help of migratory skeletogenous cells that form the perichordal tube. These cells get inside the inner sheath by penetrating the outer sheaths at the base of each arch.

Starting from Teleosts right up to Mammals, it is the perichordal tube that is converted into a bony ring distinct from the notochordal sheaths forming the vertebral centrum. In *Anamnia*, however, Herring forms an exception inasmuch as both the sheath and the perichordal tube ossify. In *Amniota* the perichordal tube in the vertebral region is converted primarily into an inner and an outer ring.

Although the majority of vertebrates conform to the linear series with regard to the centrum formation, such types as *Amia* among Teleostomi, *Amblystoma* among Urodela, *Bombinator* and *Xenopus* among Anura, show deviations from this fundamental ground plan, as a result of adaptation to changed conditions of life (Fig. 2).

The neural arch in Urodela is composed of a pair of cartilaginous arches, called *basidorsalia*, and a dorsomedian plate, called *supradorsal*. These arch elements are present in almost all the



CLASSIFICATION OF VERTEBRA BY GADOW

Fig. 1.

vertebrate series. Thoracic and caudal vertebræ of Chelonia, as well as the different vertebræ of Lacertilia, Ophidia, Crocodilia, Aves and Mammalia retain the Urodelan condition. The cervical vertebræ of Chelonia as well as vertebræ of Teleost and Anura, however, differ from the above series in having no distinct *supradorsal*; while some Teleost, *viz.*, *Haddock*, is peculiar in having the basidorsal arch as membrane bone.

In the cervical and caudal vertebræ of Chelonia as well as in the vertebræ of Urodela and Ophidia, two additional arches are found associated with each centrum. Both these arches are, in the beginning, composed of connective tissues which ultimately become membrane bond without passing through the stage of chondrification; one of them is placed anterior and the other posterior to the basidorsal. At a later stage, owing to ossification and fusion, these three separate arch elements lose their distinctness; therefore, in an adult vertebra, a single neural arch appears to be present. The existence of these membrane bone arches was missed by the previous workers. Another point that was also overlooked by the previous workers is the degeneration of the cartilaginous cells which occur together with the inner perichondrial layer of the basidorsals of Urodela. By modification of the above condition

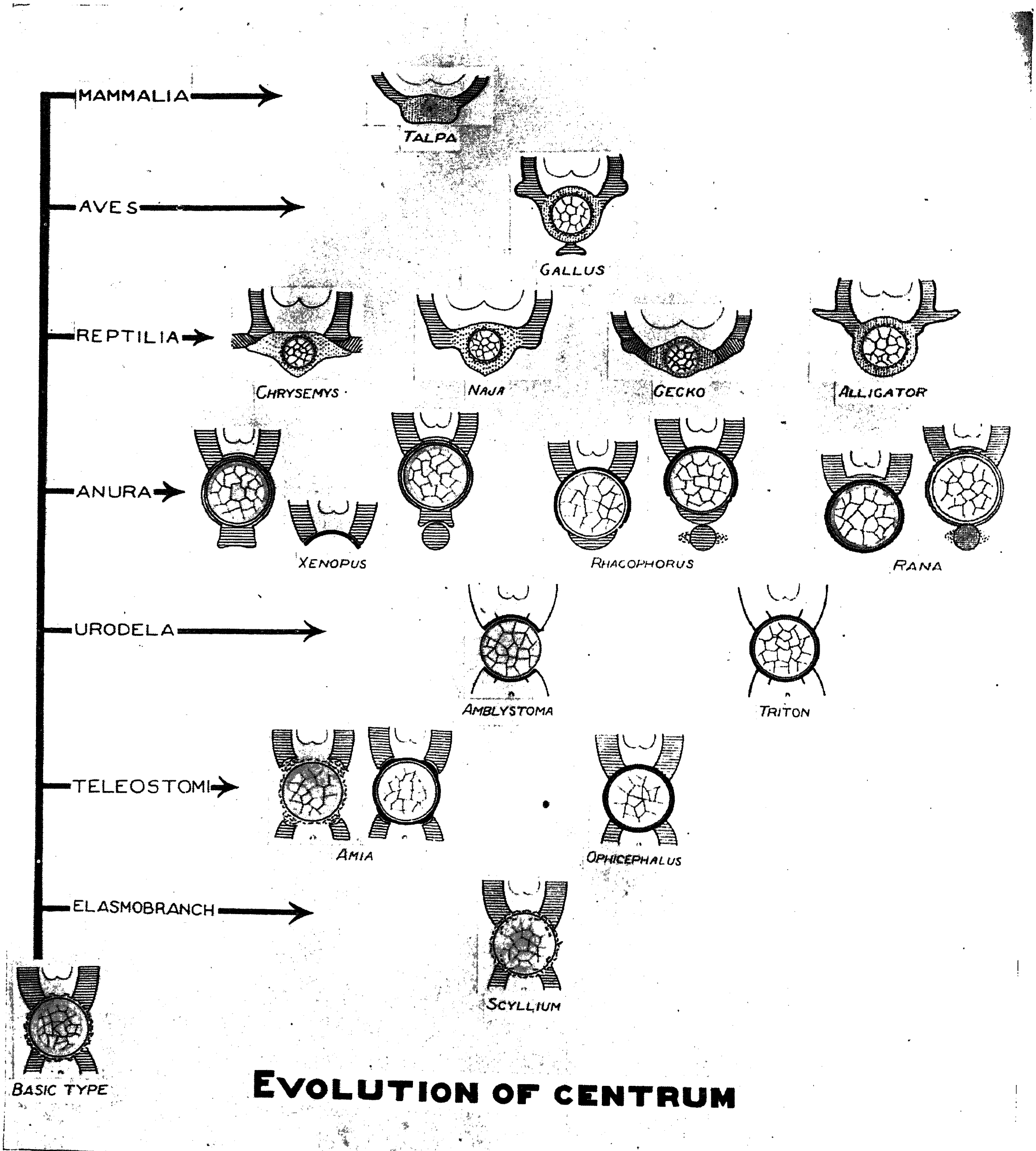


Fig. 2.

such as the addition of anterior and posterior membrane bone arches in Urodela, Ophidia, and in cervical and caudal vertebræ of Chelonia, or by their displacement, as in the thoracic vertebra of Chelonia, the seemingly diverse types of the neural arch have been evolved. The dorsal spine in all cases, except the thoracic vertebra of Chelonia, is formed from the mid-dorsal roof of either the anterior connective tissue arch or from the supradorsal.

With regard to the lower arch of the vertebra, it may be said that this arch is composed like the basidorsal, of a pair of basiventralia and a median infraventral piece. This typical condition

is found generally in the caudal vertebræ of Urodela, Reptilia and Mammalia. Considerable modifications of this typical condition occur in different groups and also in different regions of the vertebral column. In the trunk region of the Elasmobranch and some of the Teleosts, a pair of basiventralia exist as divaricated transverse rods. In Urodela, the rods are very thin and membraneous, except in *Necturus* where they are cartilaginous. The basiventral element persists in the membraneous condition throughout life, but the previous workers have erroneously stated that the basiventral element fuses with the other elements to form the centrum as in Aves and Mammalia. In some cases the basiventral elements of either side fuse into one piece to form, either the intercentrum as in Lacertilia, Ophidia, and Aves, or the hypochordal structure as in Teleost and in the Urostyle region of Anura. The ventral arcualia are similar in composition to the dorsal arcualia in being made up of two membrane bone elements in addition to the cartilaginous arch. The basiventralia also degenerate like the basidorsals in Urodela and here also there are spinous processes on the midventral surface of the anterior connective tissue arches. Thus, however diverse, apparently, the vertebral arches may seem to be, all of them can be derived from the Elasmobranch type with some additional structures to protect the caudal blood-vessels efficiently.

The transverse processes or diapophyses, are present in the vertebrate series from Amphibia to Mammalia. The position of the diapophysis varies in the different classes and in some cases varies even in a particular genus.

The rib, in all cases, starts its development within the lateral myotomes away from the vertebra and is subsequently articulated with the diapophysis. In such ribs as have two facets, one of the facets, *viz.*, the tuberculumn, articulates with the diapophysis, and the other facet, capitulumn, articulates either with the parapophysis, or with the membraneous basidorsal element, as in the case of Aves and Mammalia. In the adult condition, this membraneous basiventral loses its identity in a dried skeleton and we find that the capitulumn articulates with the body of the vertebra.

In some Anura, such as *Xenopus* and *Bombinator*, and in some Reptilia such as *Gecko verticillatus* and *Tropidonotus stolatus* or *Naja naja*, some of the caudal ribs are articulated with the diapophyses in the larval stage, but in the adult stage these are fused with diapophyses, thus producing a long massive structure seemingly like diapophysis, the identity of the ribs being lost due to fusion.

Successive vertebræ were yoked together in the embryonic stage by longitudinal processes that were cut into two halves by a strand of migratory connective tissue cells so as to produce the articular facets. The migratory connective tissue cells also divide the originally continuous perichordal tubes into vertebral segments, and the direction followed by these cells determines whether the centrum is to be of procœlous, opisthocœlous, or amphicœlous type. The course adopted by the migratory cells was influenced by the movement of the embryos. The synovial cavity originates by the splitting and separation of the split halves of the strand of migratory cells.

The developmental history of the vertebral column, as revealed by the study of comparative embryology, is full of significance, inasmuch as it shows a kind of uniformity in the processes of growth and differentiation and gives a glimpse into the mode of origin, formation, and modification, of a morphological character which has an important bearing on the evolutionary history of the vertebrates. The results of embryological studies are of great value to the evolutionist. They probe deeper into the mysteries of life and open new fields of investigation bordering on the realm of experimental studies on the embryonic life of animals.

ANTHROPOLOGY.

President: MR. H. C. CHAKLADAR, M.A.

PROBLEMS OF RACIAL CLASSIFICATION OF THE INDIAN PEOPLES.

IN India racial classification has so long proceeded on very scanty anthropometric data, and hence it has been quite unsatisfactory. Risley initiated anthropomorphic measurements in India, but the data obtained by him supplemented by those collected by others, are quite inadequate for such a vast country as India, especially as the Indian peoples are divided into innumerable independent groups that do not intermarry. Risley's classification of the Indian peoples, based upon this inadequate material, into seven racial types, has rightly been rejected by anthropologists. Risley gave, for example, the racial designation of *Mongolo-Dravidian* to the peoples of Bengal and Orissa, though they are not marked by Mongoloid features at all. Then again, Risley's Dravidians fall at least into four racial types: (1) the dark, long-headed, wide-nosed type which has been given the unsatisfactory designation of *Pre-Dravidian* by some and which has been called *Proto-Australoid* by Dr. Hutton in the last *Census Report of India* although craniological measurements have shown clearly that the theory of a common racial stock for the jungle tribes of the Deccan and the aborigines of Australia is quite untenable; this type had better be called simply *Veddaic*; Hutton's theory of its migration from Asia Minor is also disproved by the great difference in the nasal index between the ancient Mesopotamian and Indian skulls; (2) the Munda-Kol group of Chota Nagpur which possesses considerable affinity with the former, but has points of difference also; (3) the long-headed, fine-nosed type, speaking Dravidian languages who, on account of their Mediterranean affinity, had best be called *Indo-Mediterranean*, independently of any reference to the language they speak; (4) and lastly, the round-headed, fine-nosed type with Alpine affinity which claims numerous individuals amongst the Dravidian-speakers. The two latter types are not peculiar to the Dravidian-speaking area alone, but are of a much wider distribution in India. Intensive anthropometric work involving 60 measurements and 31 somatoscopic observations on each individual among the people of Bengal by the author, shows the presence, both among the high castes, such as the

Radhi Brahmins, as well as the low castes like the Muchis, of a predominant round-headed type, and also of an appreciable number of the Indo-Mediterranean type, this latter type being more numerous among the lower castes than among the higher. Anthropometric investigations in other parts of India would probably show a very wide distribution of these two types. Both of them are represented in the skulls excavated at Mohenjo Daro, and they appear to have been the earliest importers of advanced civilisation and culture into India.

The speakers of Aryan languages are represented by two groups in India, one, the round-headed type with Alpine affinity mentioned above, and the other, a tall and long-headed type which has been called *Proto-Nordic*, and the dialects spoken by two groups belong to two distinct branches of the same Aryan tongue. The present distribution of the round-heads in India in the marginal areas in the west, south and east, as also their presence at Adichanallur, shows that they must have entered the country earlier than the *Proto-Nordics*. As such they must have initiated the Vedic culture in India which the tall, long-heads, arriving later, absorbed from them. The Vedic culture was carried, even in the Rigvedic age, by the long-haired, brown-robed *Munis*—pioneer missionaries of the Vedic religion—over a great part of India, from the Western to the Eastern Ocean, as the *Rigveda* (X, 136) puts it. The Brahmana portion of the Vedas speak of mighty empires established by the Vedic Aryans in eastern India. The charge of impurity brought against the peoples of Sind, Gujerat and Konkan in the west and Bengal and Orissa in the east, belongs to a much later literature, and is due to their trade and intercourse with foreigners by land and sea; this the purists in the midland where the later Vedic literature flourished, condemned in severe terms, and prescribed the most distressful penances for them; in the midland itself, the people were getting fossilised in their habits and customs, with a narrow outlook towards life, and they began to think that the habitation of the pure Aryans was confined within very narrow limits,—between the Ganges and the Jumna. But the presence of tribes at a low stage of culture, but resembling the Indo-Aryans in their physical features over the wild area from the borders of Assam to the hills of Annam, amply proves that people with Indo-European features had traversed the whole of northern India from the western gates to the eastern frontier, and passed through the forests and hills beyond, even up to the Pacific, in very early times.

No sound and definite conclusions, however, about the racial composition of the Indian peoples, are possible without further anthropological material, and therefore extensive measurements should be taken in all parts of India, preferably by local investigators with an efficient training in anthropological method, and possessing a knowledge of the language of the people among whom they work. In England, an appeal has recently been issued "to set on foot a comprehensive survey of the past and present populations of Great Britain"; the need for such a movement in India is much more urgent, as the anthropological work so far done is of the nature of a preliminary survey only.

AGRICULTURE.

President: MR. A. K. YEGNA NARAYAN AIYER, M.A. (Mad.), DIP. IN AGRIC. (Cantab.), N.D.D., F.C.S.

SOME ASPECTS OF SCIENTIFIC RESEARCH AS APPLIED TO INDIAN AGRICULTURE.

ONE of the peculiar features of agricultural research has been the test by which its success is generally measured, *viz.*, the extent to which results of immediate practical value and application are attained and adopted by the agriculturists of the country. A policy therefore which will combine the need of attaining such quick and practical results without at the same time sacrificing the accuracy and reliability that experiments conducted over a long series of years alone can guarantee has to be adopted, which restricts considerably both the kind of subjects that could be taken up and the manner in which it could be pursued. The test, however, is bound to become more severe as the years go by under the new form of Government. But the record of the past 25 years is one of signal success both for research and propaganda more than justifying the expenditure on the various Departments of Agriculture and certainly encourages us to hope that in the future as in the past agricultural research can fully meet the test. The instance of Mysore is given in illustration, where improvements have taken place on an extensive scale. Improved ploughs, threshing appliances, sugarcane mills, and pumping installations have largely displaced the traditional methods. Oilcakes and artificial manures have come into general use; new crops, new and improved varieties of groundnuts, ragi, paddy, cotton, sugarcane are grown on thousands of acres; spraying against arecanut and coffee disease has been extensively taken up; the prickly pear has been exterminated, inoculation of cattle against diseases made thoroughly popular; serum and vaccines are manufactured locally and mortality from the deadly disease "Rinderpest" effectively kept down. (The address gives a full description of these interesting developments.)

Encouraging as these results are, progress can be greatly speeded up if profitable and ready markets for produce can be assured preferably by means of local manufacturing industries which will furnish an outlet for these crops. This is strikingly demonstrated by the improvements which have taken place in the cultivation of sugarcane for the new factory at Mandya in the Mysore State, where the use of improved ploughs, artificial manures, growing of improved varieties of sugarcane and its cultivation by special methods have all come into vogue within less than a year in contrast with the period of several years which they have taken elsewhere in the absence of such stimulus. A measure of all-round prosperity has also been ushered in as the result of this ready outlet for all the cane grown by the ryots which augurs well for other improvements. The development of the cultivation of Cigarette Tobacco in the Madras Presidency has led to similar results in that part of the country, as likewise the making of casein for the dairy farmers in parts of Bombay. The organisation of special Committees on the lines of the Indian Central Cotton Committee which will comprise growers,

scientific workers, manufacturers, and traders in respect of each important crop or group of crops in India, is likely to lead efficiently not only to a solution of the many problems of crop improvement, but also to an exploration of their commercial utilisation by local manufacturing industries and to the kinds of progress illustrated by the sugar industry described above.

The sugar industry has brought into prominence the question of the utilisation of molasses in a manner profitable to the industry and beneficial to agriculture. The manufacture of alcohol of all grades including absolute alcohol for use for various industrial purposes offers great promise and Mysore has already made a beginning which is worthy of all the support which the Government can give. Among its other uses, the making of cattle feed mixtures offers almost unlimited scope and will meet one of the crying needs of Indian Agriculture. Experiments in the making of products like molascuite with the addition of begasse dust, groundnut shells and haulms or shredded straw are suggested as promising methods of utilisation. The work now in progress for utilising it as manure will have to be continued for several seasons more to eliminate practical difficulties in the application and to make the results more definite and conclusive.

The utilisation of the bye-products which are at present mere waste products in respect of other crops also is a subject which needs greater attention, if only as a means of making the cultivation of these crops more profitable, leaving aside the question of industrial advantages. Arecanut husks, plantain stems, groundnut husks, paddy husk, cotton stalk, coffee pulp, are some of the materials that come in this category and the methods of one kind or another which have from time to time been suggested may with advantage be examined and work on alternative methods also undertaken for investigation.

The subject of "*quality*" in crops and the possibility of improving it by methods of manuring is one of great importance and deserves to be taken up without further delay. So far all manurial experiments have had for their object only an increase in the quantity of the produce concerned and little or no attention has been paid to the effect on the composition of the commodity. Many factors to which the economic value of a crop is due such as the sugar in sugarcanes, oil content in oilseeds, starch in potato, the burning quality and nicotine content in tobacco, staple in cotton, quality in rice, protein in wheat, keeping quality in fruits, etc., are already known in a general way to be affected by the soil constituents and manuring, but the matter has not so far formed the subject of serious investigation. What really constitutes quality in many crops like rice and coffee for example and to what constituent or constituents such quality is due will have also to be gone into as a preliminary, but in respect of sugar, starch, oil, proteins and known essential principles to which the other crops mentioned owe their quality, this difficulty does not exist and the problem is less complicated. So far, the performance at the weigh-bridge alone has been the test of the action of the manures and judged by this test many a manurial experiment has yielded results either contradictory or inconclusive. It is not at all unlikely that if attention should be directed to the composition of the crop as well these experiments will tell a different and a very valuable tale.

Such exclusive importance attached to the quantity alone with no regard paid to quality or other reactions of the crop leads also to the one-sided manuring now becoming common with its dangers to the permanent fertility of the soil; for in the large majority of Indian soils nitrogenous manures alone produce satisfactory increase in the yield, phosphates and potash giving either very little increase or none at all.

The effect of soil constituents sometimes called catalysts including even the rare elements is also worthy of study as in addition to their reported increase of yields it is possible that connection may be traced between them and some of the baffling plant diseases put down now to physiological disturbances, viruses and so on, much in the manner of the subtle effect of vitamins in the animal body. As a practical need of immediate importance is a strengthening of the staff for the investigation of plant diseases and pests and increased attention devoted to their investigation. The loss due to these in the aggregate is stupendous and for most of them cheap and simple remedies are extraordinarily difficult to suggest. Many indeed are the most baffling and the problem is really one for more than one branch of science. A many-sided attack from the Mycological, Entomological, Chemical, Botanical and Agronomic sides has to be organised in regard to these with provision for proper co-ordination and co-operation. Among pests that have assumed special importance recently is the borer pest on sugarcane which is a serious menace to the sugar industry. A large-scale campaign of parasitic control is indicated as about the most feasible while the action of light of different kinds, or irradiation and the newly-patented Entoray light traps need to be tested extensively.

As an allied subject, the problem of weed control may be referred to, special mention being made of the "touch-me-not" pest in the Mysore Malnad which is over-running the tract to the despair and dismay of the people and where some kind of biological control as in the case of the prickly pear alone appears to be likely to meet the situation.

In the field of cattle improvement work has been somewhat halting and tentative owing to the conflict of views regarding methods, whether it should be by crossing with foreign breeds or by selection from local breeds. Matters such as adequate fodder supplies and their conservation, and the problem of the dead load of useless cattle have added to the difficulties. But, on the other hand, we are bringing diseases under control, popularising the castration of scrub bulls and the keeping of proper stud bulls and are thus removing some of the old obstacles; while the large demand for milk due to the growth of cities is acting as a powerful stimulus to cattle improvement. Conditions are thus favourable for some marked progress in the near future.

Among the many economic factors which set effective limits to the spread of improvements is the lack of proper marketing organisations. The creation of the new department for Agricultural Marketing is therefore welcomed as a powerful ally to the scientific worker in his

attempts to increase the profits of farming. Lines of work which will benefit the country as a whole, both grower and merchant alike, as the result of the present marketing surveys are indicated. The opinion that science has led to over-production and the present depression in agriculture is strongly controverted. As long as there are millions of people who though able and willing to work have still to remain ill-fed and ill-clad, it is useless to talk of overproduction or superfluity. What Indian agriculture wants on the other hand is science and still more science to rescue it from the ills that beset it on all sides.

MEDICAL AND VETERINARY RESEARCH.

President: LT.-COL. H. E. SHORTT, I.M.S.

IMMUNITY IN PROTOZOAL DISEASE.

THE subject of Immunity in Protozoal Diseases was chosen because of its interest for a Medical Practitioner, Veterinarian and Biologists. Immunity is defined as the result of the two opposing forces of the invading parasites and of the invaded hosts. It was formerly held that the mechanism of immunity in protozoal diseases differed from that of bacterial diseases. It is, however, now believed from evidence available that the mechanism does not, in any manner, differ appreciably in bacterial and protozoal infections. Foreign substances acting as stimulants are called antigens and the resulting specific substances which react with them are called anti-bodies : it is almost certain that all substances which are complete antigen are protein in nature. The phenomena, which occur when antigen and anti-bodies are brought together, are agglutination, lysis, precipitation, complement fixation, phagocytosis in the presence of opsonins and bacterio-tropins. The theoretical concept which explains these reactions is the classical theory of Ehrlich, *viz.*, the side chain theory; while this theory has undergone modification it forms a good working hypothesis. These various reactions, agglutination, etc., are probably the result of one and the same anti-body performing different functions. The union of antigen and anti-body takes the form of an aggregation of globulin particles around the antigen. The result of this union at the surface of cell, sensitises it equally to Lysis, to complement and fixation, to phagocytosis by leucocytes and flocculation by electrolytes, each phenomenon depending upon various factors.

Trypanosomes are suitable protozoa for the study of such immunity reactions. They multiply by binary fission. If they are injected into a susceptible animal, the multiplication will be by geometrical progression. The most accurate method of determining whether such immunity is operative is to make a curve of the parasites in blood which can be denoted by the equation $X = R - D$ where X is the number of parasites at any specific time, R the number produced by division, D number destroyed. If a white mouse is inoculated with a pathogenic Trypanosome such as *T. rhodesiense* and the events followed, it will be found, that after the incubation period of 4 days, there is a continual increase of trypanosomes showing that the host exhibits no immunity response whatever. If, however, the same parasite is injected into a guinea-pig, after the usual incubation period there is an increase of parasites and a decrease in the number of parasites alternately till the animal dies. There is probably a rapid destruction of parasites during what are called the crises, these crises happening over and over again. The mouse exhibited no immunity. The guinea-pig was more successful and it stood the infection for some time. If we can imagine an animal a little more resistant than the guinea-pig, we arrive at a working arrangement between host and parasite in which the host supplies a habitat to the parasite and the latter makes a minimum of demand on the vitality of the former. Trypanosomes can be considered destroyed in guinea-pig by what may be called trypanolysin. The few parasites which resist trypanolysin have become biologically altered giving a relapse strain resistant to trypanolysin. If a non-pathogenic trypanosome, *viz.*, *T. lewisi* is injected into a mouse, there is an incubation period followed by multiplication and crises in which a large number of trypanosomes are destroyed, later re-multiplication, a second crisis in which all the parasites are destroyed. The mouse is now immune to infection. There is here probably reproduction-inhibiting mechanism in addition to the lysin. Other parasiticidal mechanisms are, phagocytosis and alterations in the level of blood sugar.

In malaria, the immunity reaction mechanism is probably very similar to those already explained. Most of the work has been done on Bird Malaria. The parasite in Bird Malaria has a sexual and an asexual cycle, and it is only with the latter that we need deal. There is the usual incubation period after the infection, when probably there is no immunity response. There is then the period of acute attack in which multiplication of the parasites occurs in geometrical progression. Crises follow, and there is destruction of the parasites, not due to any retardation of the rate of reproduction, but possibly due to (i) the natural unsuitability of the Bird for the parasites, (ii) phagocytosis, and (iii) perhaps decrease in the level of blood sugar. In Malaria, there is a latent period after which a relapse may occur. The theories which explain the latent period are various. Parthenogenesis, specialised resistant asexual forms, are such theories. The balance of evidence is, however, in favour of asexual reproduction at a low level during latent period. The immunity is only present while the host still contains living parasites. The difference in malaria and trypanosomiasis is, in the former there is a temporary suspension of the parasiticidal mechanism, whereas in the latter there is a development of a resistant form of trypanosomes. Experiments on mammalian malaria can be conducted on Monkeys which are quite suitable. Complement fixation tests and precipitin tests have been conducted on malarial sera with various antigens; some workers claim a good deal of success with such tests. Phagocytosis is perhaps not the primary agent in mammalian malaria. There is also a change in the electrical charge of the red blood-cells in Bird Malaria, inversely proportional to the parasite count, an important factor in inducing the phagocytosis.

In Leishmaniasis, both visceral and dermal, there is no reason to suppose that the difference in the mechanism is in any way different from the other protozoal diseases. In *Kala-azar* the reduction in electric charge is very great

indeed. In Piroplasmosis (containing the families of *Babesiidæ* and *Theileriidæ* which are of great importance affecting cattles, horses, and dogs) the same phenomena as in avian malaria are met with, there being a minimum number of parasites, during the latent period in the blood of the animal, the animals can at this period be rendered immune by drugs. This immunity is not complete, as another strain of the same parasite will reproduce all the phenomena of infection.

In this discussion, we deal with the biological interactions, only a part of which is within our knowledge and under our control. Practically therefore, we are attempting to solve the equations many of the factors of which are unknown. The mechanism at work is probably similar to, if not identical with, those found in bacterial diseases. In Virus infections and in some Bacterial diseases, life-long immunity may be obtained, but in protozoal infection one may be immune to one strain, but not to another strain of the same parasite. Historically this may be explained as due to non-migratory habits of ancient animals and host-parasite interactions giving immunity to the local strain only. Another point is that immunity lasts as long as there is a regional infection.

PHYSIOLOGY.

President: DR. W. BURRIDGE, D.M., M.A., F.N.I.

SOME FUTURE LINES OF ADVANCE IN PHYSIOLOGY AND MEDICINE.

PHYSIOLOGISTS at one time primarily concerned themselves with the muscle-nerve preparation of the frog, and as a result built up a science yet current which is founded on three basic hypotheses. The three are: (1) that natural stimulation, such as that of the eye by light, is a process precisely similar to that of exciting an isolated and quiescent muscle or nerve to activity by electric currents, (2) that all organs of the body remain as quiescent as do isolated muscle or nerve until excited to activity by an agent, usually external, called the stimulus, (3) that the process of stimulation depends on the explosive decomposition of unstable colloidal complexes, called excitable substances, through the shock or commotion conveyed to them by the passage of electric currents.

These three theories, either individually or severally, have been regularly treated as facts for the purpose of forming other theories or explanations of how any organ of the body behaves. The validity of the established science thus depends on the validity of these basic hypotheses none of which was ever the subject of formal scientific proof. They are instead presumptions used as working hypotheses, and they have been worked so long that they have now become the physiologist's equivalent of the theologian's article of faith. Any doubt of them is physiological heresy.

Their truth could not be challenged so long as physiologists neither knew the laws which govern the stimulation of rhythmically active tissues nor the modes of behaviour of the same tissues when they were stimulated to greater activity. The evidence of fact filling these gaps is now available. It demonstrates that the process of stimulating a rhythmically active tissue to greater activity is entirely different from that of exciting an isolated muscle or nerve to activity by electric currents. No suspicion of such differences was in our philosophy, yet the former type of stimulation is undoubtedly natural because it occurs within the living body. Whereever also natural stimulation can be examined, it follows the laws that govern the stimulation of rhythmically active organs.

The new facts available now leave no reasonable doubt that physiologists in their experiments have often stimulated rhythmically active organs to greater activity, but without being able to recognise what they were doing because of lack of knowledge both of the laws governing this stimulation as well as of the behaviour appropriate to it. They further did these experiments in the firm belief that they were exciting quiescent tissues to any activity at all. There was never, however, concordance between what ought to be, if the primary hypotheses were true, and the actual findings. These discordances were adjusted by special secondary hypotheses, and no alternative to this course was available so long as there was no suspicion of any alternative primary hypotheses. The new knowledge of rhythmical tissues demonstrates in consequence that much of what has hitherto been regarded as sound science is really an adaptation of facts to original false presumptions. This is especially the case with the explanations of physiology concerning the nature of the activities of the central nervous system. Physiology here is at least a generation behind the New Psychology and is destined to remain static until it appreciates the fact that a tissue in an active state acquires through its activity properties which are not present in tissues in the state of rest.

A change in the composition of blood or lymph, though it may be called a change of internal environment, implies much more than does a change of external environment inasmuch as it implies a change in the chemical composition of the dispersing media of the colloidal systems constituting the living cells which those fluids bathe, as well as those of the bathing fluids themselves. Any consideration of such changes therefore which entirely ignores the existence of colloidal systems must be essentially incomplete. It is the exception rather than the rule, however, to find what are called changes of incernal environment considered in terms of the properties of colloidal systems.

Numerous experiments demonstrate that many substances affect the properties of living tissues by exactly those two modes which are predictable if those properties were dependent on processes taking place in colloidal systems. The same experiments demonstrate that in the adsorption processes and in the state of aggregation of their colloids living tissues possess two sources of energy for their activities, whereas the traditional presumption has been that they could only possess one. The two sources of energy are moreover so independent that the capacities of the tissue can be augmented through the one at the same time that they are decreased through the other. The basic hypothesis which presumes one sole source of energy makes the facts inconceivable since it requires one to imagine something being both up and down at one and the same time.

Alcohol is an interesting drug which exerts two opposite actions which are readily understood when one realises that every organ has two sources of energy for the drug to act on. In contrast with this case of understanding the presumption that an organ can only possess one source of energy provides a number of insoluble puzzles for apparent solution. The social importance of the drug has further determined the development round it of a special but pseudo-science which attempts to explain what is actually inexplicable so long as one holds fast to the faith that living tissues can only possess one source of energy for their activities.

The two sources of energy have been called the kinesiphores and the uncontrolled experiments which men perform on themselves with alcohol can now be used to throw light on the part played by each kinesiphore in our mental activities. The donation to nerve cells of two sources of energy, where previously one had been presupposed, *plus* the donation to them of inherent rhythmical activity instead of inherent quiescence provides possibilities beyond previous dreams. The knowledge that a nervous path consists of a number of relays normally attuned but on each of which alcohol can differently act enables the user of a wireless set to appreciate more about the inco-ordination of drunkenness than what the best science could hitherto have taught.

PSYCHOLOGY.

President: J. M. SEN, M.Ed. (Leeds), B.Sc., F.R.G.S., F.N.I.

MEASUREMENT IN EDUCATION.

IN all problems of education two things are important: (1) the child with his given potentialities and limitations which we may call *heredity*, and (2) the *environment* (physical, nutritional, social and ideational), in which the child grows. Education is a function of these two *variables*, although no precise formula governing their relationship is yet available.

The child begins life as a field for the operation of two forces—heredity and environment—which may often work in harmony, but sometimes in opposition. The child does not grow by spontaneous unfoldment. Growth is a continuous process of assimilation, a taking possession of an ever widening environment, a ceaseless redistribution of energies flowing into the organism from the universe around.

For the teacher the problems of heredity often assume the spurious garb of the inheritance of acquired characteristics. Many teachers are liable to the fallacy of apparent transmission of acquired habits, whereas the general trend of evidence is in favour of the transmission of *educability*, which is a very different thing from the direct transmission of the *results of education*. All that the practical teacher can attempt to do is to make the best of the hereditary potentialities of every child placed in his care by a suitable manipulation of the child's environment. To discharge this responsibility aright, he has to acquaint himself with the technique of the measurement of "Intelligence". With the introduction of compulsory Elementary Education in some of the Provinces and States of India, the problem of weeding out the pupils who are unfit for Secondary Education, is assuming gigantic proportions. An efficient process of classification is rendered possible by the application of educational tests. If educational tests suitable for Indian conditions are devised, and applied at several stages in the career of each pupil, collossal waste in educational expenditure and effort could be avoided.

Current examination methods of classifying pupils are still labouring under serious defects such as the *personal equation* of the examiner. The finer aspects of the results of education are apt to be missed by the crude procedures employed by the examiners—which are still far too detailed and factual. The current system of examinations does not make for *thinkers*, but for plodders; it does not foster an equiting alert mind, but a dogmatic retentive mind. In place of a live wire our schools produce a blotting pad. They can take faithful impressions, but cannot provide the dynamic force which makes for creative activity.

These evils of present-day education which are bound up with our system of examinations, cannot be rectified, until the teacher takes up seriously the task of standardising suitable tests of intelligence, character, and of achievement in school subjects. The task is gigantic, but I feel sure that the teachers will rise equal to the occasion.

Discussions held at the Congress.

1. The Making of Humus and its Applications. (*Agriculture and Medical Sections.*)
2. The Problem of Nutrition in India. (*Medical and Physiology Sections.*)
3. The Teaching of Biology in Schools. (*Botany and Zoology Sections.*)
4. The Scope of Preparations of Fine Chemicals in India. (*Chemitstry Section.*)
5. The Utilisation of Molasses. (*Chemistry Section.*)
6. The Classification of Archæan Rocks of India. (*Geology Section.*)
7. The "*Myxophyceæ*", "Saltation in artificial cultures of fungi", "The Standardisation of Vernacular names of Indian Plants", "Chromosome Morphology and polyploidy" and "The importance of anatomy and toxonomy". (*Botany Section.*)

Spectroscopy: Its Applications.

(Sifting the Secrets of the Universe by the Analysis of Light.)

By Everett White Melson.

(Bausch & Lomb Optical Company, Rochester, N.Y.)

MORE than two hundred and sixty years have passed since Newton discovered that a beam of light could be separated by means of a prism into bands of violet, indigo, blue, green, yellow, orange and red. This was the beginning of a series of experiments that have supplied more information about the nature of the physical world than any other single phase of research. Whether the constitution of a star, the earth or an atom is under investigation, the analysis of light plays a constantly increasing part.

This phenomena of the separation of light is the basis of spectroscopy which, beginning with the study of the solar spectrum, now reaches into the expanding fields of metallurgy, chemistry, physics, medicine and biology.

The dispersion of light is due to the varying refrangibilities of these different colours in passing through media of varying densities. In passing through a quartz prism, for instance, violet waves have less speed than red and consequently are more retarded, or refracted. Kirchoff and Bunsen developed the following conclusions relative to the three more important types of spectra. When light from an incandescent gas or vapour is examined by means of a prism, its spectrum is seen to consist of a number of bright lines, coloured images of a spectroscope slit, which are always the same for the same gas under the same conditions of temperature and pressure. Thus the spectrum of sodium vapour at the temperature of the Bunsen burner consists of a single pair of bright yellow lines corresponding to the Fraunhofer lines D_1 and D_2. Lithium gives a single line of deep red. Thallium light is green and strontium emits a blue light. The light from hydrogen, the prototype of all other spectra that originate in atoms, shows four well-marked lines, one in the red and one in the blue corresponding to the Fraunhofer lines C and F, and two fainter lines in the violet. Such a spectrum is known as a bright line spectrum. Its presence indicates that the source of light is a mass of incandescent gas or vapour under a pressure so low that the gas molecules have freedom of motion to execute whatever form of vibration they will.

When the light from an incandescent solid or liquid, or from a mass of incandescent gas under high pressure, is analysed, the spectrum is found to contain all colours from red to violet, showing no discontinuance at any point. This continuous, or band spectrum indicates that the source is an incandescent solid, liquid, or gas under high pressure. The spectra from molten metals, from the filaments of incandescent lamps or from the carbon tips of an arc lamp are all continuous spectra.

In 1814, Fraunhofer made a spectroscope and saw for the first time a pattern of many fine dark lines across the solar spectrum. In the spectra of the stars he observed these same dark lines. It was discovered that if a beam of white light is passed through a layer of gas or vapour before entering the spectroscope, this vapour will sift out and absorb precisely those light rays, or colour, which the gas or vapour would itself emit if incandescent. It is this absorption of light by gases which is so important in astronomic spectroscopy.

The absorption bands, whose relative positions were determined and lettered by Fraunhofer, afford a ready and accurate means of designating lights of definite colours. Many substances present characteristic absorption spectra. A piece of cobalt glass absorbs all colours, except a small strip in the red, and in the blue end of the spectrum. The absorption spectrum of chlorophyll shows a dense black line in the red, while blood, even if greatly diluted, shows two characteristic bands in the green.

Since the character of the light emitted by an incandescent gas depends first of all upon the vibrations of its constituent atoms, it follows that a study of the light emitted by a glowing gas affords direct testimony concerning its chemical composition. Consequently if the bright line spectrum of any substance is once known, whenever this spectrum presents itself, we may at once conclude that the given substance is present in the source of light, whether it is in a Geissler tube in the laboratory or from a fixed star in the vast depths of space.

The spectroscopic method of analysis is characterised by its ease and rapidity, and especially by its exceeding sensitivity. In the case of a Bunsen burner, 1/14,000,000 of a milligram of sodium is sufficient to show the characteristic sodium lines, while in the spark of an induction coil, 1/80,000,000 of a milligram of lithium may be detected. The extreme sensitiveness of the method has led to the discovery of numerous new elements which have been present in minute quantities as impurities in the substances under examination. They revealed themselves through characteristic new lines in the spectrum. Among the elements so discovered are cæsium, rubidium, thallium, indium and gallium.

The instrument with which this work is done is the spectroscope or spectrograph. Its operation is based on the dispersion of light. If sunlight is passed through three prisms having the same refracting angle, one of flint glass, one of crown glass, and one a hollow prism with plane glass sides and filled with water, the resulting spectra will be found to differ greatly in length. The spectrum from the flint-glass prism is about twice as long as that from the one of crown glass, and three times as long as that from the water prism. The various colours undergo widely different deviations through prisms of the same angle but of different substances.

A careful study of the dispersion of various refracting media is therefore a pre-requisite for the scientific construction of optical instruments. Since different glasses vary widely in relative dispersion, it is within the power of the optical glass maker to produce at will prism combinations that will give either deviation without

dispersion or dispersion without deviation, according as the need may arise. Basically all designs of the spectroscope consist essentially of four parts; the slit, the lenses, the dispersing system and the observing or recording system. Various optical and mechanical arrangements of these units are used, depending on the purpose for which the instrument is designed.

In the simple direct vision spectroscope a cemented prism of the Amici type is often used. This is composed of one flint unit and two crown-glass units, the angles and glass being so chosen that the F-line of hydrogen is undeviated. In the instruments designed for photography of the ultra-violet spectrum the sixty degree type of prism is usually employed, but in order to avoid image doubling, due to the birefringence of the material, it is composed of two thirty degree prisms, one of right quartz and one of left. The rotation produced in the first half of the prism is exactly neutralised by the reverse rotation in the second half. This type is called the Cornu prism.

If the instrument is designed for visual observation it is equipped with a cross-hair and eyepiece. If a permanent photographic record is desired, the eye-piece is replaced by a plate holder equipped with an operating mechanism. The last method is used almost exclusively in studies of the ultra-violet region, and in the case of the better visual spectroscopes the design is such that the telescope can be replaced by a camera. Certain inherent characteristics which depend on the design of the instrument determine its efficiency. Chief among these are dispersion and resolving power. To alter dispersion either the index or the angle of the prism must be altered; to alter resolving power the base of the prism must be changed, at the same time utilising its full aperture.

Perhaps the earliest and greatest use of the spectroscope until recently was in the province of astronomy. According to Dr. Edwin Hubble, of the Mount Wilson Observatory of the Carnegie Institution, the study of absorption spectra is the dominating feature of modern astronomy. "They furnish," says he, "an astonishing amount of information concerning the physical condition of stars and even of planets and nebulæ. Either directly or indirectly they indicate surface temperatures of stars, surface luminosities, total luminosities, distances, and velocities in the line of sight." The spectra of over 90 per cent. of all the stars are dark line absorption spectra.

It was the study of the spectra of distant nebulæ with the spectrograph which disclosed a peculiar characteristic to Dr. Hubble—the dark lines, or absorption bands, are not in their usual positions. The lines are all displaced toward the red end of the spectrum and the displacements increase with the faintness of the nebulæ observed. Observations are summed up in the statement that the fainter the nebula the larger the red-shift. Since apparent faintness of nebulæ is confidently interpreted in terms of distance, the conclusion is that red-shifts increase with distance. Precise investigations indicate that the relation is linear—red-shifts are equal to distances times a certain constant.

Many ways of producing such effects are known, but of them all only one will produce large red-shifts without introducing other effects which should be conspicuous but actually are absent. This one known permissible explanation interprets red-shifts as due to actual motion away from the observer. On this interpretation the nebulæ are rushing away from us, and the farther away they are, the faster they are travelling. The velocities increase roughly 100 miles per second for each million light years of distance.

It is by the accurate measurement of the colour of well-defined spectral lines that the astronomer is able to discover whether the body emitting them is approaching or receding, on somewhat the same principle that the noise emitted by an automobile horn sounds deeper in pitch when it is receding from us than when it is approaching. So the light from a receding body appears redder than that of one approaching.

Spectroscopy has become such an important study at the present time that international conferences are frequently held at which authorities report recent advances in numerous fields of investigation.

At a recent conference at Massachusetts Institute of Technology, one of the reports concerned one of the great riddles of medical science —the extreme complexity of the biological units which by their balance produce health or illness. One of these units, porphyrin, was shown by Dr. Calvin B. Coulter to be capable of analysis by the spectroscope with a sharpness, precision and simplicity which usually apply chiefly to the inorganic substances like the metals. Porphyrin is the base of red blood-cells. It is also the base of chlorophyll, the green colouring matter of plants, which they use to synthesise food through the agency of sunlight. The two porphyrins differ mainly in that the blood one is combined with iron while the green plant substance is combined with magnesium. Because of this, some scientists have speculated on the possibility that far back in evolution the green of the plants and the blood of man may have originated from the same source. This may be a link between plants and animals.

Coulter has found further evidence of this kinship of plants and men in porphyrin which he extracts from cytochrome, a pink pigment existing in the cells of virtually all those living things using oxygen. This cytochrome, he finds, is combined with magnesium, so that a porphyrin-magnesium combination is not an exclusive patent of the chlorophyll-green plants, but belongs also to the red-blooded races. This porphyrin, which he places under the light beams for spectral analysis, is obtained from bacteria. He dissolves it out of their cytochrome, which they use to obtain oxygen, somewhat as man uses his lungs to get oxygen. He studied this porphyrin when combined not only with its original magnesium, but also with copper, cobalt, nickel and tin.

At room temperature the spectroscope showed a general "curve" indicating the presence of porphyrin, but when Coulter cooled these porphyrins down to temperatures between 100 and 200 degrees below zero, the curves showed much more detail. They showed precision comparable with the spectroscopic curves which identify metals.

Spectroscopic investigation has also been of great assistance in the study of hæmoglobin, another vital body substance whose function is to transport oxygen from the lungs to various parts of the body. Dr. David Drabkin, of the University of Pennsylvania, has been able to carry out experiments far in advance of any of those previously made, and although the composition and structure of the plasma is still unknown, important work toward its solution has been done.

Just why nature has chosen a coloured pigment to carry oxygen, when there seem to be other substances which could do the job as well or better; why globin with its huge molecular weight of 68,000 is used to carry oxygen whose molecular weight of 32 seems insignificant in comparison; and how globin is attached to the other parts of the blood are problems science is anxious to solve. On the answers may hang some of the most valuable discoveries medicine has made concerning the human body.

And then there is the continuous search for a cure for cancer. Active in this is Prof. Ellice MacDonald, of the University of Pennsylvania, who has examined more than 10,000 liquids in an endeavour to find one that can be injected into a cancer to enhance the curing power of X-rays and radium. The liquid sought is one that will emit ultra-violet light of a specific wave-length when activated by X-rays or the gamma rays of radium. This secondary emanation is regarded as most important, but it is essential to have the radiation at the base of the cancer since it is almost impossible to transmit these rays any distance.

Incidentally, the most deadly radiation yet discovered, a narrow range of ultra-violet light, will destroy living cells almost instantaneously, according to Dr. MacDonald, who made these observations by means of a specially constructed quartz-microscope. In his search for the liquid which he believes will be of tremendous value in the treatment of cancer, Dr. MacDonald has discovered several which radiate the desired ultra-violet light. But the requirement that they be volatile and non-poisonous to human tissue has thus far proved a stumbling block.

The detection of cancer in its earliest stages is nearing through the discovery by Doctors A. J. Allen and E. B. Sanigar, that cancerous blood is different from that which is free of the disease. These new qualities of cancerous blood were discovered by means of the spectroscope in experiments on rats—and recently on human beings. While the work is admittedly in its early stages, it may suggest to other workers in this field a new and profitable method of investigation.

Some investigators have gone so far as the accurate forecasting of death by spectroscopic analysis of the blood of diseased persons. To the great astonishment of attending physicians in Paris, P. and M. Lecompte de Nouy, of the Pasteur Institute, predicted deaths by spectroscopic examination which occurred within 24 hours, although death was not believed imminent.

In their research more than 8,000 samples of the blood of men, horses and sheep were examined and various characteristics discovered by means of spectroscopic investigation of the serum and white plasma of the blood, which were plotted on charts. The resulting curves, similar to those on business trends, show a "remarkable constancy, so great that the curves can readily be superimposed on each other. The various fluctuations in the curves represent the various structural features of the blood as indicated by the various colours which manifest themselves by the absorption of light passed through the serum or plasma into the spectroscope."

When departures from this general trend are noted they can safely be interpreted as an indication of pathological disturbances. Such alterations must correspond to very deep chemical modifications affecting the chromophoric (colour) elements which belong to very stable chemical groups. Thus these changes in the blood show that very definite and basic chemical changes are occurring. These changes have been found for the most part to precede death.

It is also through spectrum analysis that marked progress toward the complete and positive identification of pepsin is expected. Although science has for years realised the importance and function of this important digestive juice, and has been fairly sure that it was composed of carbon, hydrogen, oxygen and other elements, just what amount of these substances constitute pepsin and how they are chemically arranged has remained a mystery.

Only recently, through the researches of Dr. Geo. I. Lavin, of the Rockefeller Institute, was it discovered that pepsin is a protein, but much additional information was needed. Now, Dr. Lavin's investigations with the spectroscope suggest that pepsin is constituted of amino-acids. His method was to compare the spectra of pepsin with those of substances of which it might be composed.

An equally fascinating phase of spectral study is the method of analysing the potency of vitamins by spectroscopic light. The eye of the spectroscope is so sensitive that it would take a pool of cod liver oil 300 feet deep to look the same as one paper-thin sheet of pure vitamin D, according to Dr. R. A. Morton.

For vitamin D, it appears, the spectroscope should not be used except with the pure vitamin, named calciferol, which is 40,000 times more potent than cod liver oil. This is because in the oil, or any substance containing vitamin D, colours which register only in ultra-violet light mask the lines which reveal the potency of the vitamin. Only biological tests with living animals are safe for testing the strength of vitamin D preparations.

But for vitamin A, the investigation shows, the spectroscope is the best method of analysis, exceeding even the biological tests. Further, the evidence of the spectroscope affords reason to believe that there is more than one kind of vitamin A. It indicates that there are probably several massive groupings of molecules, all very similar, each of them carrying the medicinal or physiological effects of vitamin A. With remarkable precision the spectroscope shows the existence of these apparently different groups, but they are so close together that there is at present no way of separating them to find out whether one group may be more potent than another.

At the University of Cambridge investigators have found that the fertility vitamin E absorbs

light in a distinct and characteristic fashion thus making positive identification possible. By dissolving vitmain E, prepared from wheat germ seeds, in aclohol, it was found that a sharp absorption occurs at a wave-length of 2900 Å. This wave-length is in the invisible ultra-violet region, near the actinic rays of light which cause sunburn. The key test in this research was to show that the vitamin E which produced this absorption really produced a biological effect when given to experimental animals. Such an effect was found, and according to Doctors Martin, Moore and Schmidt, "the vitamin caused a female rat which had shown characteristic resorption gestation to produce a litter of eight live young".

In none of the phases of spectrum analysis has more progress been made than in the examination of metals. Both in quantitative and qualitative spectrographic analysis the detection and identification of metals and alloys has shown the spectrograph to be the most sensitive instrument known, far outdistancing chemical analysis in speed and accuracy. This phase of spectrography alone is creating a new and exhaustive literature on the subject. Here, the purpose is to report the investigations that affect the lives of all of us more immediately.

And one of the most interesting reports comes from Prof. Jacob Cholak, of the University of Cincinnati, which describes the detection of lead in the human system. While qualitative determination has been possible for some time, exact quantitative measurement has been exceptional without the use of the spectroscope. Chemical analysis, heretofore employed, requires anywhere from 10 to 14 days, while the spectroscopic analysis is possible in a period varying from 24 to 48 hours.

Describing the detection of lead in the human brain, Prof. Cholak reports that a percentage of three-tenths per hundred grams has been found in the brain of an individual. Through the use of the spectroscope, he has been able to detect minute amounts in other parts of the body. Another advantage of this method over the chemical analysis is that very small amounts of fluid, tissue or bone are required for the test. Using known lead concentrations to add to the spinal fluid and establishing a relation between this ratio and the lead concentration, it is possible to detect one hundred millionth of a gram of lead per cubic centimetre. Dr. J. Stuart Foster, of McGill University, hopes to apply this method to the study of lead as a possible cause of multiple sclerosis.

The selenium poisoning of cattle has long annoyed ranchmen in various parts of the world. There has been no way to discover the small amounts of this poisonous element in the soil. Livestock feeding on vegetation growing on this infected soil are killed. But at last both selenium and sulphur have succumbed to the spectroscope—in this case one of special design, because of a very long wave-length in the infra-red or heat region of the spectrum. By making special adaptations, and by the use of the new infra-red sensitive photographic plates, Dr. George Harrison and Dwight Merrill have found it possible to record and measure the light emitted by the atoms of sulphur and selenium. As much as one part in a million of these substances can be detected in the presence of other materials.

Not only is the result important to cattlemen and farmers, but the method is expected to prove useful to metallurgists. Recently the presence of small amounts of sulphur and selenium in certain alloys have been recognised as an important factor in determining the characteristics of the alloy. By the use of the spectrograph the amount of these elements in the alloy can be measured accurately and kept at the right specification.

Even in the field of diamond mining the spectroscope is proving exceptionally useful to the geologist. It tells whether certain rock is the kind in which diamond is likely to be found. Although diamond-bearing rock may appear on the surface like any other rock, the spectroscope is able to tell swiftly whether diamonds may be hidden there.

What the instrument actually does is to detect the presence of so-called volcanic "pipes" formed by the explosion of volcanic lava through the earth's crust. It is this explosion with its tremendous heat and pressure that is believed to be responsible for the formation of diamonds although the exact process is not known to science. Detection of the "pipes" however does indicate the proper type of rock and thus eliminates considerable hit-or-miss prospecting. The spectroscope is also used in the study of volcanoes to identify the gases from which the molten lava is formed. Further researches in this field may assist science in forming an accurate picture of the substances which comprise the inner layers of the earth's crust.

Research Notes.

The Behaviour of the Conformal Transformation at the Boundary.

OSTROWSKI (*Acta Math.*, t. 64, 81–184) has obtained very general and precise results in this extensive and profound paper. Let G_1 be the simply connected region in the z-plane which is transformed into G by means of the Schlicht function $w = f(z)$. Let w_0 be a point on the boundary of G, corresponding to z_0 on the boundary of G_1 and let $f(z)$ be continuous at z_0. If $\triangle_z = z_0 z_1 z_2$ and $\triangle_w = w_0 w_1 w_2$ be two small triangles, then the transformation is said to be relatively conform in z_0 if $\triangle_z$ and $\triangle_w$ are similar in the limit. If $z_1 \hat{z}_0 z_2 \sim w_1 \hat{w}_0 w_2$ then the transformation is said to be "*winkel-treu*" in z_0. It is conform when $\dfrac{f(z) - f(z_0)}{z - z_0} \rightarrow$ to a limit other than zero or ∞. (In this case it is also called absolutely conform.) It is clear that there may be relative conformity or "*winkel-treu*" even if it is not absolutely conformal. One of the important results that Ostrowski has obtained is that if the transformation is "*winkel-treu*", then it is also relatively conformal if z_1 and z_2 are always contained in an angular neighbourhood of z_0. This follows from the result, that if $z \rightarrow z_0$ angularly in G_1, then arg $f'(z)$ also $\rightarrow$ to a limit.

As regards "*winkel-treu*" sufficient conditions were already obtained by Caratheodory; this is true whenever there is a tangent to the boundary of G at w_0 and G_1 is the unit-circle. Lindlöf proved later that if the boundary curve in the neighbourhood of w_0 possesses an "L-tangent" (*i.e.*, if all the chord-directions in a neighbourhood of w_0 approach the direction of the tangent at w_0 when the ends of the chord $\rightarrow z_0$), then arg $f'(z) \rightarrow$ to a limit when $z \rightarrow z_0$ inside the unit circle in any way. All these results are precised and generalised by Ostrowski in this work.

He has proved therefore that the necessary and sufficient condition for relative conformity is that the transformation should be "*winkel-treu*"; for this it is sufficient that G and G_1 should have corners of equal magnitude (he has utilised a more general definition of corners than the usual) at w_0 and z_0. Now if the corners are r and r_1 ('in mag.') then Caratheodory had proved that $\dfrac{w_1 - w_0}{w_2 - w_0} \sim \left(\dfrac{z_1 - z_0}{z_2 - z_0}\right)^{r/r_1}$ when the ratio $\left|\dfrac{z_2 - z_0}{z_1 - z_0}\right|$ lies between two positive limits. Ostrowski has proved that in the general case arg $f'(z) - (r/r_1 - 1)$ arg $(z - z_0) \rightarrow$ to a definite limit when $z_1 \rightarrow z_0$ inside an angle in G_1. If the portions of the boundary have L-tangents at z_0 and w_0, then this is true for all approaches of $z_1 \rightarrow z_0$. This is proved by means of a "*Rand-verzerrung*" theorem, which is the following

$$\frac{\dfrac{f'(z)}{f(z) - w_0}}{z - z_0} \rightarrow \frac{r}{r_1}$$

when $z \rightarrow z_0$ within an angle in G_1. This result is proved under a weaker assumption that the conformal representation at z_0 is angularly proportional with the proportionality factor r/r_1 instead of the supposition of the existence of corners at z_0 and w_0. This theorem has been proved by making use of a theorem of Lichtenstein which has been generalised and newly proved by Ostrowski. The theorem proved by Ostrowski is that if $P(r, \theta)$ is the value of a Poisson-integral in the inside of the unit-circle, then $P'_r(r,\theta) = 0\left(\dfrac{1}{1-r}\right) P'_\theta(r,\theta) = 0\left(\dfrac{1}{1-r}\right)$ when (r, θ) approaches a point of the boundary of the unit-circle in any manner.

He has derived very many interesting results from these and has generalised his results much further. Firstly, he has considered the case when $z \rightarrow z_0$ along one side of the boundary at z_0 [Halb-seitig]. Secondly, Warschawski's results about higher derivates are precised. Thirdly, the "*Rand-verzerrung*" theorem is generalised to the case where the existence of the tangents at z_0 and w_0 are dispensed with and in their place an assumption about the relatively small oscillation of the chord directions in the neighbourhoods of z_0 and w_0 of the corresponding boundaries is introduced. Fourthly, he has examined the case when $r = 0$. In this case although all these results are not true, some of them are proved to be true.

He has also obtained an interesting set of conditions for the representation of an analytic function by means of a Poisson-integral involving the existence of certain

integrals taken over the boundary of the unit-circle.

K. V. I.

On Transcendent p-Adic Numbers.

MAHLER (*Comp. Math.*, Vol. II, Fasc. 2, pp. 258–275) has extended Gelfond's proof of the theorem, *viz.*, that for two real or complex algebraic numbers α and β [different from 0 and 1] $\dfrac{\operatorname{Log}\alpha}{\operatorname{Log}\beta}$ is either rational or transcendental to the realm of p-adic numbers also. Gelfond's proof makes use of the coefficient conditions of an integral function which are obtained by means of Jensen's theorem, *i.e.*, by means of Cauchy's residue theorem. In the realm of p-adic numbers there is no analogue of Cauchy's theorem as the Archimidean axiom is not valid. He has therefore developed a corresponding theory of analytic functions in the p-adic realm. The result he has obtained is the following.

Let p be a prime-integer and α and β be two numbers different from 0 and 1 satisfying the following condition

$$0 < |\alpha - 1|_p \leqslant \frac{1}{p} \qquad 0 < |\beta - 1|_p \leqslant \frac{1}{p}.$$

Then if $\dfrac{\operatorname{Log}\alpha}{\operatorname{Log}\beta}$ is algebraic, then it should be a rational p-adic number.

His method of proof can also be applied in the ordinary case; so we have here another proof of this theorem. One of his lemmas furnishes an interesting theorem on the approximation of algebraic numbers. He has obtained the following:

Given a set of algebraic numbers $\alpha_1, \alpha_2, \cdot\cdot\, \alpha_t$ there exists a constant c depending only on them with the following property—

If $\phi(\alpha_1, \alpha_2, \cdots \alpha_t) =$

$$\sum_{h_1=0}^{N_1} \cdots \sum_{h_1=0}^{N_t} A_{h_1 \cdots h_t}\alpha_1^{h_1}\alpha_2 \cdots \alpha_t^{h_t}$$

is any polynominal, the absolute value of the maximum coefficient being A, then either $\phi = 0$, or

$$|\phi| \geqslant [c^{N_1+N_2+\cdots N_t+1} A^{n-1}]^{-1}$$

where n is the degree of the algebraic field containing the α's.

K. V. I.

The Proton-Spectra of Magnesium, Silicon and Sulphur, obtained by Bombardment with Fast α-Particles.

IN the *Physikalische Zeitschrift* (1935, 36, p. 804), O. Haxel of Tübingen describes the results obtained by bombarding Mg, Si and S with fast α-particles from Th B + C, and comes to the important conclusion that the energy levels of the resulting nuclei, *viz.*, Al, P and Cl agree with one another within the errors of observation. This indicates that the α-particles inside nuclei have a distinct existence and that the energy levels of the remaining system of neutrons and one proton are identical. The protons dislodged from the bombarded elements were counted by means of a Geiger counter and the results obtained when the opening of the counter was screened with different absorbing foils were represented on a graph. This showed the presence of three groups of protons of range 31 cms., 40.5 cms. and 52 cms. The corresponding energies are $1 \cdot 2 \times 10^6$, $2 \cdot 0 \times 10^6$ and $2 \cdot 9 \times 10^6$ electron-volts. Since the three groups of protons obtained from each of the elements Mg, Si and S are similar, while their isotopic constitution is different, it was concluded that the proton emission was due to the most abundant isotope in each case, *viz.*, Mg_{24}, Si_{28} and S_{32}, and the difference in the energy of the proton groups was attributed to the formation of excited levels in the resulting nuclei, *viz.*, Al_{27}, P_{31} and Cl_{35} respectively. The experiments now showed that the difference between the lowest state and the first excited state and that between the first and second excited states were $1 \cdot 7 \times 10^6$ and $0 \cdot 8 \times 10^6$ *e.-v.*, $1 \cdot 6 \times 10^6$ and $0 \cdot 8 \times 10^6$ *e.-v.*, and 1.6×10^6 and 0.65×10^6 *e.-v.* respectively in the case of Mg, Si and S in this order. In other words, the differences in the energy levels are the same in the three cases within the error of observation. Thus we have here the evidence for the existence of a close relation between the nuclear spectrum and the nuclear structure.

T. S. S.

Artificial Space-Gratings for obtaining Laue-Patterns with Visible Light.

SINCE the Laue-diagrams obtained by the interference of X-rays scattered by a crystal-grating cannot be made visible on a fluorescent screen on account of too small an intensity, attempts have been made to set up space-gratings suitable for the wave-lengths

of visible light. So far only a very special case of a space-grating had been obtained by the reflection of a plane cross-line grating such as a uniform wire-gauze. Now W. Kramer of Stuttgart describes an interesting method of obtaining space-gratings suitable for use with visible light (*Physikal. Zeit.*, 1935, p. 841). The method depends on the formation of colloidal silver layers at distances of $\frac{\lambda}{2}$ when a photographic film, on which stationary light-waves have been formed by reflection as in Lippmann's method of colour-photography, is developed. The light forming the stationary waves is also used to project an image of a cross-grating on the photographic emulsion so that a space-grating is formed when the film is developed. As a suitable cross-grating the negative, obtained by photographing a "screen" used in making half-tone blocks, was employed. A green-ray filter was placed before a mercury arc lamp and the green light was passed through a condensing lens on to the "screen" above mentioned. An image of the screen was produced by a good photographic objective (only the Microplanar of Zeiss and the Microsummar of Leitz were found suitable) and was thrown on a photographic plate with a mercury mirror behind it for the formation of the stationary waves. In this way gratings of $9 \times 9 \times 0 \cdot 7$ mm. with grating constants equal to $8 \times 8 \times 2\mu$ were produced and showed Laue spots. These spots were however not monchromatic on account of the imperfections in the grating. Better space-gratings can be produced when better cross-gratings are employed and these space-gratings can be used to demonstrate the laws of crystal diffraction to a large audience.

T. S. S.

High Pressure Technique and its Application.

PROF. BRIDGMAN has evolved a new technique (*Phys. Rev.*, 1935, **48**, 825) of producing very high hydrostatic pressure combined with high shearing stress. Mere hydrostatic pressure has not many applications unless it be combined with high shearing stress. Many ordinary crystals which exhibit polymorphism, change their crystal structures by a shear. To effect such polymorphic transformations, shearing stress is quite necessary. Bridgman has found that ordinary paper does not change even though a pressure of 50,000 kg./cm.^{2} was applied but it changes to a translucent horn-like mass when subjected to a hydrostatic pressure with a shear. Interesting results were obtained in the case of the lead oxides. PbO_2 detonated violently leaving metallic lead while the yellow oxide, PbO, was decomposed quickly to metallic lead. The red modification of HgO and P changed to the black ones. He also found that certain substances like celluloid detonated and that certain substances combined at high pressures with detonation like Cu + S. With the intense high pressure of 50,000 kg./cm.^{2}, Bridgman has been able to effect polymorphisms in the cases of Bi, Hg, Tl, Te, Ga and I_2. Certainly these investigations of Bridgman point to a new field of research of great interest.

N. S. N.

The Two Amylases of Barley.

FROM the study of the hydrolysis of starch by amylases, two alternative hypotheses have been advanced regarding the constitution of starch: according to Kuhn, starch is a single entity consisting of α- and β-glucosidic linkages which are hydrolysed specifically by the α- and β-amylases yielding α- and β-maltose respectively; according to the other view, advanced by van Klinkenberg, starch is composite, one component designated α-starch is selectively hydrolysed by α-amylase and the other β-starch by β-amylase. The hydrolysis of starch by amylases and its bearing on the constitution of starch, has been re-investigated by Hanes (*Canadian Journal of Research*, 1935, **13, B.** 185). By employing the "Yeast removal methods" to remove quantitatively and selectively glucose, or glucose and maltose, he has shown that the products of β-amylase action on starch are exclusively maltose and erythrogranulose, the latter being an unhydrolysable residue which is precipitated by alcohol of about 50 per cent. concentration; it gives a strongly opalescent solution in boiling water and is stained blue or violet (depending on its concentration) with iodine. The action of α-amylase on both starch and erythrogranulose is characterised by (1) a partial flocculation of the substrate which occurs early in the substrate, and (2) the disappearance of the iodine colouration. Contrary to the conclusions of van Klinkenberg, α-amylase does not selectively hydrolyse the erythrogranulose fraction of starch, but produces reducing

substances both from β-starch and erythrogranulose fractions.

The hydrolysis of erythrogranulose by α-amylase yields substances capable of being hydrolysed by β-amylase, and are therefore not maltose. When a mixture of both α- and β-amylases acts on starch, the β-starch fraction would be acted upon by both α- and β-amylases, the greater part of the hydrolysis being effected by the β-amylase. The hydrolysis of the erythrogranulose fraction would be initiated by the α-amylase and the products of the primary breakdown would be further decomposed by β-amylase. There is no evidence to prove that the two fractions, β-starch and erythrogranulose, pre-exist as separate entities in starch, as the possibility of their being fragments of a single molecule must not be overlooked.

A. K.

The Determination of Mercury in Viscera.

AN improved method for the determination of mercury in viscera has been described by Clive Newcomb, S. Rajagopal Naidu and K. S. Varadachar in the *Analyst* (1935, **60,** 732). The usual method is to destroy the organic matter with potassium chlorate and hydrochloric acid under a reflux, precipitate the mercury as sulphide which is filtered off, washed with carbon disulphide and weighed. In the present method, the organic matter is destroyed with a mixture of nitric and sulphuric acids and the mercury distilled off as the chloride by drawing a current of air, saturated with HCl, through the solution containing the mercury, and subsequently the mercury is precipitated from the distillate as sulphide. The precipitate is dissolved in bromine water and filtered, to free it from sulphur, the excess of bromide boiled off, the mercury reprecipitated as sulphide which is collected on a tared gooch and weighed. A simple apparatus is described to carry out the distillation quantitatively.

The advantage of the method, besides its greater accuracy over the older one, is that it enables the separation of mercury from metals of the second group such as Copper, Bismuth, Lead and Arsenic, where they occur. Moreover, Arsenic, when it occurs together with mercury, is converted in this method to the pentavalent state and is retained in the distilling flask whence it can be recovered quantitatively.

Hairiness of Leaves in Relation to Resistance by Injury by the Potato Leaf-Hopper in Soya Beans.

THE interesting fact that pubescent types of the Soya bean are resistant to the attacks of the potato beetle leaf-hopper *Empoasca fabæ* (Harris) is brought out in a study by Johnson and Hollowell (*Jour. Agri. Research*, **51**, No. 4). Progenies of three generations of a cross between a rough hairy type and a glabrous type of soya bean were raised and tested. Glabrous individuals of both the homozygous, glabrous and the heterozygous progenies were all heavily infested with *Empoasca*, severely stunted in growth and had curled leaves with necrotic margins. The rough hairy individuals on the other hand were almost entirely free from *Empoasca* and grew vigorously and their leaves showed no symptom of leaf-hopper injury. In glabrous and appressed hairy introductions got out and grown by the side of these progenies the glabrous plants were heavily infested while the hairy ones were free. Some hairy plants contained in the glabrous introductions, probably as segregates, were also free from hoppers. Though it is probable that the resistance may be due to the hairiness or to some character the inheritance of which is controlled by the same hereditary complex as the pubescence no evidence of such a character was obtained in these experiments.

A. K. Y.

Control of the Woolly Aphid by means of Insect Parasites.

ATTENTION is drawn to the great effectiveness of the parasite *Aphelinus mali* in the control of the woolly aphid (*Eriosoma lanigerum*) in the apple orchards of New South Wales. So satisfactory has been the method that the spraying method usually adopted heretofore has become unnecessary. The effect however of the sprays which have to be used to control other insect pests and fungous diseases on apple trees, on these beneficial woolly aphid-controlling parasites has now become important to study and the same has been undertaken and the result reported by N. S. Noble (*Agri. Gaz. of New South Wales*, Vol. 46, pt. 10). The sprays studied were nicotine sulphate, various miscible oils and lime sulphur. Laboratory experiments showed that the sprays had little or no effect on the emergence of

the parasites. It is also concluded that this applies not only to the parasites which were in the pupal stage but also to those in the larval stage. Under field conditions however it is found that caution is necessary; while where the parasite is firmly established the spraying is not injurious to it, where it has been recently introduced and spraying to control other pests is also necessary then unless the parasite has had time to oviposit and its progeny are at least approaching the mature larval stage the spraying would probably result in failure to establish the parasite.

A. K. Y.

The Banded Chromosomes in the Salivary Glands of *Drosophila*.

P. C. KOLLER (*Proc. Roy. Soc. Lond.*, (B.) Oct. 1935, **810**, 371–397) regards the banded salivary-gland chromosomes of *Drosophila* to be multiple ones consisting of four-eight-sixteen chromosomes and the bands as due to the characteristic chromosomes lying side by side. The homologous multiples pair side by side and fuse into one solid cylinder, and they exhibit relic coiling before, and both relic and relational coiling after, pairing. The salivary gland nuclei are therefore in a state of perpetual prophase corresponding with a modified meiotic prophase. In the presence of intercalary inversion, relational coiling which develops, at first promotes pairing but the fixed ends of the inversion prevent normal completion of this relational coiling and hinder pairing. Where intercalary deletion occurs in one homologue reflex-relational coiling is noticed. The attraction between the attachment chromomeres is not only not specific but unlimited and thus the attachment chromomeres of all chromosomes fuse to form one body, "The Magma". These properties of coiling are analogous with those found in the prophases of mitosis and meiosis and are probably due to the analogous changes in the molecular spiral.

Chromosomes and X-Rays.

M. J. D. WHITE (*Proc. Roy. Soc. Lond.*, Ser. B., Dec. 1935, **812**, 61–84) has found that the irradiation of the spermatogonia in Locusta results in both lethal and non-lethal effects. The former lead to the pycnosis of cells while the latter lead to chromosome abnormalities, fragmentation being the commonest. The fragmentation of the X-chromosome is much rarer than that of the autosomes. Ring chromosomes and chromosomes with two spindle attachments result from fusion. Certain spermatogonial cells show a tetraploid nature as regards chromatids but exhibit only a diploid number of spindle attachments. This is regarded as a new kind of abnormality (*diplochromosomes*) and is believed to be due to inhibition of division of spindle attachments following on irradiation. The spindle attachment is independent in certain respects in its behaviour from the rest of the chromosomes. In Acridiidæ, the author regards that the spindle attachments are not terminal as is usually believed but sub-terminal. The effect of X-rays on the material at different times after irradiation have been studied and it is shown that breakage can take place in both chromatids at the same level after splitting (a possibility previously rejected by Mather and Stone) and at about the end of the resting stage there occurs a period when fragmentation and translocation occur with great facility.

Williston's Law relating to the Evolution of the Skull Bones in the Vertebrates.

PROF. S. W. WILLISTON in discussing the skull bones of Permian reptiles noted the law that evolution besides being irreversible is also a law "that the parts in an organism tend toward reduction in number, with the fewer parts greatly specialised in function, just as the most perfect human machine is that which has the fewest parts and each part mostly highly adapted to the special function it has to subserve". This law has been amply substantiated by the work of W. K. Gregory and his pupils [*Am. J. of Physical Anthrop.*, 1935, **20** (2), 123] who have closely examined the vertebrate skulls of both fossil and living forms. It has been pointed out by the authors that this law is a part of the principle called anisomerism where primitive sub-equal morphological units "become differentially enlarged, reduced, distorted or fused with the neighbouring elements". The application of this principle must have taken place during six great successive revolutionary periods. During the Silurian the agnathus forms must have been converted into jaw-bearing vertebrates. The air-breathing, lobe-finned fishes into Stegocephalian amphibians during the Devonian, and the primitive stegocephalia

into stem-reptiles during carboniferous, mark the next two stages. Permian and Trias are characterised by the appearance of mammal-like reptiles and the conversion of these into mammals. Arboreal primates are derived from primitive mammals during Jurassic to Eocene. Perhaps Upper Miocene and Lower Pliocene mark the stages of the appearance of Man. With this knowledge as a background, a count of the "number of suturally separate bones in the various sub-divisions of the skull" and also the total number of skull bones of an adult animal, has been made. It has been shown how differently the principle of anisomerism has acted in different regions of the skull.

Geologic Deductions from Earthquakes of Deep Focus.

THE prevalent view that Earthquakes generally originate at shallow depths has been challenged of late years and it has been shown by seismologists that many Earthquakes are of really deep-seated origin. From a mass of interesting geophysical data collected with regard to Earthquakes of deep focus J. S. De Lury (*Journal of Geology*, Vol. 43, No. 7) has deduced certain conclusions of fundamental importance. He has shown that since strength increases with depth, deep-seated Earthquakes require mighty stresses. Secular cooling disturbs the initial thermal gradient and the stresses caused by such differential thermal activities are responsible for Earthquakes of deep focus.

Further a doubt has been raised regarding the existence of a shell of weakness below the crust, and this has a direct bearing on the assumptions of isostasy. It is probable that records and observations of deep-seated Earthquakes will necessitate a revision of many of our conceptions of crustal mechanics.

M. R. S.

Note on the Manganese-Lime Series of Garnets.

SOME time back a bulletin (*Mysore Geological Department Bulletin*, No. 14) was published by Messrs. M. B. Ramachandra Rao and K. Sripada Rao in which it was pointed out that the analyses of the garnets contained in the Sakarasanahalli series of metamorphic rocks agreed closely with the Spessartite of the Ilmen mountains and not with the Manganese-Lime series of Indian garnets described by Dr. Fermor. On this basis it was concluded that the Sakarasanahalli series of rocks had no relationship with the Gondite and Kodurite series of Fermor, but were merely metamorphic representatives of the Hornblende Schists. Recently Dr. Fermor has shown (*Rec. G. S. I.*, Vol. 68, pt. 3) by making use of the same analyses that these Sakarasanahalli garnets must be considered as members of the Manganese-Lime series of Indian garnets. Further with the help of numerous analyses of Indian garnets, he has constructed a very instructive diagram, where it is clearly shown that the analyses of the Sakarasanahalli garnets fall well within the curve of the Indian garnets of the gondite-kodurite series. Thus he still maintains the view that the manganese-bearing garnet rocks associated with the manganiferous limestones of the Sakarasanahalli area are connected with the well-known Gondites and Kodurites.

M. R. S.

Mechanism of "Drying" of Oils.

THE mechanism of the conversion of a drying oil into a hard solid has been investigated by several workers, and the conclusions are conflicting. A new approach to the problem is made by G. Gee and E. K. Rideal (*Proc. Roy. Soc.*, 1935, Series A, **153**, 878, 116). By the study of surface pressures and phase boundary potentials, they have been able to elucidate the general mechanism. Their results show that in "drying" of a monolayer of the maleic anhydride compound of β-elæostearin a primary unstable peroxide is formed; the latter can undergo conversion into a more stable isomer or can get polymerised directly. The polymerisation reaction proceeds by the primary activation of the monomer followed by the rapid reaction of the active material with successive molecules of the inactive monomer, so that the reaction is terminated by the disappearance of the monomer. The decreasing activity of the growing polymer is shown to be completely accounted for by a mere steric factor.

K. S. G. D.

Researches on Malaria.*

"THE Transactions of the Far Eastern Association for Tropical Medicine," recently published, contains twenty papers dealing with recent researches on Malaria. The topics may be reviewed under the following heads.

The Question of Time in Control of Malaria.—It is beyond the comprehension of an average malariologist to have to look ahead fifty or a hundred years to visualise the completion of a programme. He likes to point to Panama where malaria was controlled in a matter of months, and he views with pride the recent attack on the Pontine Marshes, where a few years have seen such a splendid victory over this disease. He forgets the enormous initial costs of these two control projects, justified of course by the results, but impossible for average tropical areas.

Moreover, the malariologist tends to seek perfection in this method and is unhappy if a single larva escapes his larvicide. Yet perfection costs money and the simple truth of the matter is that the tropics cannot afford perfection in malaria control or anything else. It is time that malariologists began to rely more on Time and less on Money, insisting on continuity of effort but not on perfection, which will always be so expensive as to be either utterly impossible or fatally sporadic.

Therefore, more and more effort must be expended in searching for biological and automatic methods of control. Such methods offer little hope at present of ever being either perfect or rapid. But they do offer the possibility of continuity and of the desired results in time.

Species of Mosquitoes.—In Europe it has been shown that the puzzling fact that in some places *A. maculipennis* carries malaria and in other places not, could be explained by the existence of different races of this species.

In the Far East analogous problems exist. Why does *A. subpictus* carry malaria in the Netherlands Indies, and not in British India? Why do *A. hyrcanus* (and its varieties) and *A. aconitus*, for example, carry malaria in some parts of the Netherlands Indies and not in others? Probably in the latter cases this can partly be explained by the number of cattle present, but it seems quite possible that also racial differentiation or a differentiation into varieties might be responsible, at least partly, for this phenomenon.

Mosquito Surveys.—Since the success of local anti-malarial measures depends chiefly upon the virtual abolition of the larvæ of dangerous mosquitoes breeding within effective range of the protected villages, it is essential that a constant check be maintained over all the potential breeding places that are to be abolished within such areas. Mosquito-larvæ surveys are consequently essential, first for the discovery of all dangerous breeding places and then for keeping watch on those that need to be eradicated.

It is necessary for efficiency that the overseers in charge of oiling should have a thorough knowledge of the habits of mosquito larvæ and still more essential that constant watch should be kept over their work by other larvæ searchers whose work is independent of the oiling staff. Larvæ surveys are thus of supreme importance in the conduct of all anti-malarial works.

Permanent Control Measures.—In the Netherlands Indies the control of malaria consisted of:

(1) The installation of a drainage system.
(2) Regular cleaning of the small grassy irrigation ditches (because they also harboured larvæ of *A. aconitus*).
(3) Planting of rice only once a year in the wet season by all the people at the same time; so that during the dry season the plain was dry and anopheles breeding well nigh impossible.

The effect of this has been to transform the appearance of villages. In place of miserable and weakly children there are now sturdy youngsters. Squalor that was induced by sickness has given way to comfort and good health.

Temporary Measures.—The use of Paris green (copper acetoarsenite) to destroy anopheline larvæ was first introduced by Barber in 1921. It has been widely applied in the United States as well as in European countries. Its low cost, portability, effectiveness for killing the larvæ in thickly vegetated surface and harmlessness to other forms of aquatic life and to domestic animals are generally recognised, and its use is, therefore, universally applicable.

* *Transactions of the 9th Congress of the Far Eastern Association of Tropical Medicine*, Vol. II, 1934. Published by the National Health Administration, Nanking.

"Paris green has the advantage of not killing vegetation, as would be the case with anti-malarial oil. Its use, therefore, in the botanical gardens is of special advantage—malaria is controlled while the natural beauty of the ponds and of the river is maintained."

Anti-Malarials.—Amongst the many factors that must be considered in estimating the therapeutic value of the three best known anti-malarials—quinine, plasmoquine and atebrin—one of the most important is the toxic action of the drugs on various organs.

It is probable that these do not act directly as parasiticides, but cause recovery from malaria through indirect means. For this reason the question of the general action of these remedies on the organism is of more importance than was thought up to a short time ago.

If plasmoquine or atebrin should be administered intravenously to patients, they should always be combined with a suitable dose of adrenaline. In case of prolonged cardiac depression after the administration of plasmoquine or atebrin, besides adrenaline and its analogues, the usually employed heart stimulants must be thought of.

Taking all forms of infections together, it has been found that quino-plasmoquine is the most effective in reducing the size of enlarged spleen, the next being totaquina Type I, atebrin, quinine and totaquina Type II, in the order named.

In tertian malaria the spleen-reducing property of all the drugs is about the same with the exception of atebrin. In quartan infection they are also effective, especially totaquina Type I and quinine. In subtertian fever all the drugs are less effective, although quino-plasmoquine shows slightly better results.

Quinine and atebrin were found to be superior to the other drugs in freeing the peripheral blood from parasites both in tertian and quartan infections.

Advantages of Atebrin.—Atebrin is the best drug available for the treatment of all types of malaria, especially in the case of controlled populations.

The treatment is short, simple and effective—one $1\frac{1}{2}$ grain tablet of atebrin for 5 days only; it has seldom to be repeated.

If administered as a prophylactic in the field each day's treatment may be given in one dose. Actual attacks of malaria should, if possible, be treated in hospital.

It is usually as efficacious as quinine in abating the clinical symptoms of malaria.

It is greatly superior to quinine in the prevention of relapses: judging by present experience the atebrin relapse rates do not exceed from 5 to 8 per cent. in subtertian, and from 5 to 16 per cent. in benign tertian malaria.

For this reason it is a cheaper drug to use than quinine.

Children need and tolerate relatively larger doses of atebrin than adults.

In serious cases of malaria the injection of atebrin seems as effective as the injection of quinine bihydrochloride.

The toxicity of atebrin is low.

A short course of plasmoquine not exceeding 0·03 gram daily for from 5 to 8 days should be given after atebrin treatment in subtertian malaria—to destroy the gametocytes. A similar course of plasmoquine will lower the relapse rate in benign tertian atebrin-treated cases.

The prophylactic use of atebrin is, under certain conditions, worthy of trial, because of its slow excretion from the body and its cumulative effect. A mass treatment of labour on heavily infected estates at the beginning of the malarial season should prove of value.

It is a powerful preventive of malaria in the sense that most of those treated with it, being cured, are rid of the disease and become non-infective to their fellows, except in areas where sub-tertian is predominant as atebrin seems to have no action on crescents.

To get the best results on estates all persons harbouring malaria, including infants, should be given atebrin, especially if they are newcomers. If this is done, it may be possible to decrease such anti-malarial measures as oiling on some estates during the relatively non-malarious season.

General.—The following resolution on malaria was passed by the Conference:

"The Ninth Congress of the Far Eastern Association of Tropical Medicine, recognising the pressing need for co-operative investigations in the problems of malaria control, wishes, in particular, to emphasise direct attention to the fundamental importance in malarial epidemiology of studying bio-chemical changes occurring in the breeding places of anopheline mosquitoes."

"This Congress considers that advances of practical utility in the control of malaria might be made if the data obtained by workers in the countries of the Far East were made comparable."

"It is resolved, therefore, that, with the consent of the Governments concerned, such investigations, conducted in various countries, be co-ordinated through the appointment of a joint committee of chemists and malariologists resident in these countries."

B. A. RAO.

The Cape Crawfish Industry of South Africa with Some Observations on the Prawn and Crab Fisheries in India.*

By B. Chopra, D.Sc.

(*Zoological Survey of India, Calcutta.*)

THE recently started series of Fishery Bulletins of the Department of Commerce and Industries of the Union of South Africa, of which No. I was published in February last year, offers an excellent opportunity for taking stock of the conditions in reference to prawn and crab fisheries in India. In the present note after reviewing the report on the Cape Crawfish Industry of South Africa, a short account of somewhat similar fisheries in different parts of India is given and a few suggestions are offered for developing the fisheries along scientific and commercial lines, as is done in South Africa and several other countries.

The crawfish industry has been in existence in South Africa for a long time past, but it is only during recent years that it has been established on a firm footing. The publication by Messrs. Cecil Von Bonde and J. M. Marchand of a pamphlet entitled "The Natural History and Utilisation of the Cape Crawfish, Kreef, or Spiny Lobster, *Jasus* (*Palinurus*) *lalandii* (Milne Edwards) Ortmann" as Fishery Bulletin No. I of the Department of Commerce and Industries, Fisheries and Marine Biological Survey Division, of the Union of South Africa, shows on what sound lines the industry is being run under the helpful and vigilant guidance of the Fisheries Department.

The report is divided into two parts, the first dealing with the natural history of the crawfish and the second on its utilisation. The importance of a scientific study of the species on which the industry is based is clearly brought out in the report. Questions connected with reproduction, life-history, ecdysis, food, migration, etc., etc., have not only a purely scientific value, but the application of the knowledge acquired by their study to the various processes of the industry is of a fundamental importance.

The first chapter of the report deals with the taxonomic position of the crawfish and thirteen other allied species occurring in South Africa. It is unfortunate that the authors have called the Cape crawfish by the zoological name of *Jasus* (*Palinurus*) *lalandii*. *Jasus*, as the systematists know, is the name that Jeffrey Parker gave in 1883 to a subgenus of *Palinurus* having certain characters on which Spence Bate later (1888) founded his genus *Palinosystus*. The latter name was, therefore, so to say, still-born and *Jasus* has thus for a long time been recognised as a subgenus of *Palinurus*. Some authors, like de Man,[1] for instance, consider *Jasus* as a distinct genus, of the same rank as *Palinurus*. The correct name for the "Kreef" would, therefore, be either *Palinurus* (*Jasus*) *lalandii*, or (if the authors consider the characters on which *Jasus* is based to be of generic importance—a view that is generally held now) *Jasus lalandii*, but in no case can *Palinurus* be considered a subgenus of *Jasus*. It may also be mentioned here that Lamarck has generally been credited as the author of the specific name *lalandii*, but as this appears to have been only a manuscript name, the authors of the report are quite justified in ascribing it to Milne-Edwards[2], who was the first to publish it with a proper description. Another point of some systematic importance is that according to de Man *Panulirus fasciatus* of Fabricius 1798, should be known by Herbst's specific name of *polyphagus* 1796; the authors have used the former name in the report.

The anatomy of the crawfish is briefly described in simple language, and the distinguishing characters between the two sexes are clearly brought out. The process of reproduction is also briefly referred to, and the hatching period is stated to last from

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* Published with the permission of the Director, Zoological Survey of India.

[1] de Man, *Siboga Expd. Rep.*, 1916, 39 a^2, part 3, 31-32.

[2] Milne-Edwards, *Hist. Nat. Crust.*, 1837, 2, 293-294.

three to five months. It is of interest to note that a female crawfish may carry as many as 200,000 eggs in a single brood.

The chapter on development and metamorphosis is of special interest in spite of the fact that there are still wide gaps in our knowledge of the complete life-history of the crawfish. The importance of studying the complete cycle is strongly stressed; its practical utility is apparent in view of the fact that " the aquarium experience gained makes it possible to rear young fish with success until they have passed the 'danger zone' and can be liberated in the open sea, there to counterbalance any depletion of the sea caused by fishing". From an examination of the smallest females "in berry" it is concluded that though rarely specimens having a carapace length between one and two inches may be mature, it is oftener that examples between two and three inches are found to be carrying eggs. From evidence gained under aquarium conditions it is believed that the berried season lasts from two to three months.

Moulting being a necessary concomitant of growth, the information given under the chapter on ecdysis is both interesting and useful, but it must be stated that the published data for arriving at the rate of growth, *viz.* ·2 inch per year, are rather meagre. The smaller fish moult oftener than mature individuals, which cast off their skin at a more or less definite season each year, the season sometimes differing even in adjoining localities.

Regarding the food of the crawfish the authors are of the opinion that the "nutcracker" jaws "have probably been provided for the breaking open of the shells of mussels and such like creatures". It will be interesting to know if this view is based on any actual observations in nature or even in aquaria. Sea weeds also form a part of the natural food of the crawfish.

The crawfish lives on the sea bottom between low-water mark and 20-25 fathoms line, and prefers a rocky bed with abundance of weeds, etc. An interesting point in this connection is that the fish is abundant on the west coast, and scarce on the east. This, as the authors point out, is no doubt due to the fact that the water along the Atlantic coast is considerably colder than that of the Indian Ocean washing the east coast.

In the absence of satisfactory results having been obtained from tagging experiments the authors have refrained from expressing any definite views on the question of migration, but it is interesting to note that one marked crawfish had travelled 13½ miles in 11 days, thus suggesting that there may be some definite migratory movements. It is hoped the new tagging methods that have been evolved after a series of experiments may prove more successful. There is no fixed proportion between the two sexes, and a dominantly male population in a particular area to-day may change into a dominantly female population to-morrow, but as such areas are generally contiguous, normal mixing of the sexes takes place without much difficulty.

The second part of the report dealing with the utilisation of the crawfish for commercial exploitation is of absorbing interest both to the scientist and to the people engaged in the industry. As is usual in such cases the history of the crawfish industry in South Africa is a tale of failures by the early pioneers paving the way to success which the present companies have achieved.

The process of canning is described in detail and the precautions taken in avoiding contamination, etc., are mentioned. That these precautions are thoroughly efficacious and that the product of the South African canned crawfish industry is entirely reliable is shown by the fact that "one large company last year paid out the sum of seven shillings and six pence in repayment of bad and damaged tins"; this sum roughly represents ·0003 per cent. of their total output. Unfortunately there have been some serious lapses also, but the whole process of canning is being thoroughly investigated with the help of an eminent chemist.

The value of the canned crawfish industry to South Africa runs into lakhs of pounds. Approximately £ 350,000 have been invested in the industry; in 1932 there were in the Union of South Africa alone 13 large factories employing 2,600 men, paying out £ 104,000 in salaries and wages, and producing canned fish of the value of approximately £ 450,000. The figures for export are equally impressive; in 1933 the Union of South Africa and South West Africa exported canned crawfish to the total value of £ 382,052. In addition to canning, an industry in the export of frozen tails of crawfish has also been established. The process involved is very simple, consisting in severing the tails from freshly caught fish, cleaning and putting them in ice and then packing and transferring them to the cold-storage chambers of steamers,

Frozen tails of the value of £93,840 were exported, chiefly to France, in 1933.

The types of boats used in the industry are mentioned and their evolution from the simple open dinghy equipped for sailing or rowing to the modern motor fishing boat, especially designed and built for the crawfish industry, is described. The actual fishing is, however, still done from the dinghies.

The methods of fishing have not, on the whole, developed very much since the industry began very many years ago. A simple type of hoop-net, with an iron hoop, and twine netting is used. The net is let down and hauled up by three bridles or legs, one consisting of the hauling rope itself, and the other two of thinner twine. The bait is tied at the junction of the three bridles and the nets are let down spaced at intervals, in a suitable place in about 20 fathoms of water. The fishermen working from a dinghy haul them up occasionally, take out the fish and set them again. When sufficient fish have been collected, the load is transferred to the mother boat which is anchored close by, and the dinghy resumes the fishing operations. When the fishing is over for the day, or has to be abandoned on account of threatening weather conditions—which is very often the case—the nets are hauled in, the dinghies are either stowed on deck, or secured astern by tow-ropes, and the mother boat returns home.

The various fishing grounds along the west coast are described. Their extent, nature of the bottom and the shore, their liability to winds and swells, the abundance or otherwise of the crawfish and other necessary details, like sanctuaries and the breeding seasons, are given in detail. The sketch maps showing the boundaries of the various grounds are very helpful.

The last chapter on protective legislation shows how the idea of declaring "close season" has had to be abandoned, except in a very few selected places. The present rules for the conservation of supplies seem to be based on sound scientific principles and on experience. The laying down of the size-limit, prohibition against catching fish in berry, declaring sanctuaries, prohibiting dumping of crawfish bodies and crawfish offal in the fishing grounds and such other restrictions are all eminently reasonable and in the best interests of the industry.

The bibliography given at the end, though not very exhaustive, as in a work of this kind it need not have been, is very useful. A. Gruvel's paper entitled "Contribution à l'etude générale systématique et économique des Palinuridae" published in *Annales de l'Institut Oceanographique* III, Fasc. 4 (1912) should, however, have found a place in the list of references. Besides giving a systematic account, the author deals with the commercial exploitation of the different species of the Palinuridae, and his notes on *Jasus lalandii* (pp. 12–14) are very useful.

The paper is illustrated with eight plates of the animal, its different parts, and larval stages, and nine sketch-maps of the fishing grounds. These are on the whole very clear and most useful.

Both zoologists and industrialists engaged on the crawfish and allied industries must feel thankful to Messrs. von Bonde and Marchand for the production of this most interesting and instructive treatise.

Now turning to the conditions prevailing in India, one cannot help wishing that industries like that of crawfish canning could be established in this country also. Vast quantities of prawns and crabs are sold in the markets of Calcutta, Bombay, Karachi, Madras and other important towns near the sea, and some quantities are sent considerable distances inland also. According to Moses[3] "both in quantity and value the crustaceans are of greater importance than any kind of fish in Madras. The prawns top the list, while the crabs come next." The figures that he collected for the sale of different kinds of fishes, including prawns, etc., show that prawns, crabs and shrimps to the value of Rs. 1,35,056-14-0 were sold in the markets of Madras City in one year. The figures given by Rai[4] for the Bombay coast are still more impressive. "Millions of pounds of prawns are caught annually. Apart from local consumption, large quantities are despatched inland, and also exported to foreign countries. The total consumption along the Bombay coast alone may be estimated at 12,000,000 lbs. valued roughly at Rs. 2,500,000. The prawn industry alone, along this coast gives employment to about 20,000 men, women and children." For the very rich prawn fisheries along the Sindh coast he estimates the annual yield roughly at Rs. 1,500,000. For Calcutta unfortunately no figures are available, but even a

[3] Moses, *Madras Fisheries Dept. Rep.*, 1923, No. 6, 139.

[4] Rai, *Journ. Bombay Nat. Hist. Soc.*, 1933, **36**, 887.

casual visit to any of the important markets of the town, and especially to Chingrihatta, a large flourishing market, more or less exclusively reserved for the sale of prawns and shrimps, would convince one of the large quantities of these crustaceans which are consumed at almost all times of the year.

In spite of the vast proportions of the prawn and crab fishing industry and the great possibilities of its expansion, it is regrettable to note that practically nowhere in India are these industries being run on sound scientific lines, or even on modern commercial methods. The fishermen still employ methods that their forefathers used and the advance of science or the development of modern commercial and marketing methods are altogether unknown to them. All that is done at present, as it was no doubt being done generations ago, is that fishermen in small family groups do the fishing, either for themselves, or in many cases for the middlemen to whom they are heavily in debt, with small country boats and antiquated appliances. The catch is sold fresh, mostly through rings of middlemen, in the markets of neighbouring towns, or where facilities are available, is sent some distance inland. It must, however, be admitted that some of the simple and primitive methods and appliances used by our fishermen are at least as efficient as those employed in countries where fisheries are being more scientifically handled. In some cases where the yield is more than the requirements of the neighbouring markets, prawns are dried, or even boiled and dried, and are exported in fairly large quantities. The methods employed are of the very simplest kind, drying being done mostly in the sun, separating of the shells by trampling or by thrashing with sticks and packing for export purposes in gunny bags. In a few places in the Madras Presidency, however, through the efforts of the Fisheries Department, improved methods are being tried and gradually adopted. It is remarkable that even in spite of these, for the most part, primitive methods a large export trade in dried prawns and of their shells—the latter are used for manure—exists in a number of centres, Karachi alone having exported these commodities to the value of Rs. 11,59,797 in the year 1929–30. Similar flourishing trade exists near Calcutta, in some places in the Madras Presidency, notably on the Malabar Coast, and also on the Chilka Lake on the Orissa Coast. Very little canning is being done anywhere at present; it was tried in Madras for a number of years, and the success, perhaps only partial, that was achieved by the Madras Government Cannery indicates that, if properly handled, a flourishing trade in the export of canned prawns could probably be set up in a number of centres along the coast.

Species like *Penaeus semisulcatus* de Haan and *Peneopsis monoceros* (Fab.) are found in abundance in suitable places all along the Indian coast and are fished in quantities to supply mostly the requirements of the local markets. These and some others are large-sized species and if organised attempts were made to do the fishing and canning, etc., on modern lines, a flourishing industry could no doubt be set up in a comparatively short time, both for supplying the local markets and also for export purposes. *Palaemon carcinus* (Fab.) also attains to a very large size and is plentiful in freshwaters and estuaries in a number of localities and could perhaps be commercially exploited on a larger scale than is being done at present. There are also several smaller species of *Palaemon*, *Leander*, *Caridina* and *Acetes* that are fished in enormous quantities all along the coast.

The crab fishing industry of India is not so extensive or important from the point of yield as that of prawns. The commonest edible Indian crab, *Scylla serrata* (Forskall), forms the basis of very extensive fishing all along the coast. In some creaks of the Gangetic Delta it is so plentiful at certain times of the year that boat-loads of it are collected by some very simple, but rather ingenious, devices.[5] *Varuna litterata* (Fab.) is another species that occurs all over the Delta in countless millions, but on account of its small size does not fetch much price. The Portunids *Neptunus sanguinolentus* (Herbst) and *N. pelagicus* (Linn.) are, however, large-sized species and are fished in fairly large quantities in many centres. Added to these there are some Potamonids—*Partelphusa* (*Paratelphusa*) *spinigera* (Wood-Mason) in Bengal, *Paratelphusa* (*Oziotelphusa*) *hydrodromus* (Herbst) in Madras and *Paratelphusa* (*Barytelphusa*) *jacquemontii* (Rathbun) on the Bombay side—that fulfil the needs of the local markets.

The lobster fishing industry could also

[5] Hora, *Curr. Sci.*, 1935, **3**, 543-546.

probably be established on a more paying basis than is at present the case, on the Bombay coast and perhaps in some other places also. *Panulirus ornatus* (Fab.) attains to a size of about 12 inches or more and is found in large numbers on rocky beds below the low tide marks in several places along the Indian Coast. Another species *Panulirus polyphagus* (Herbst) [=*P. fasciatus* (Fab.)] also grows to a large size, but is perhaps not quite as abundant as *P. ornatus*. Lobsters fetch a high price in the market and could probably be used for a flourishing canning industry. On account of their spiny shell they do not find a ready sale in some markets.

The first requirement for putting the prawn and crab fishing industry on a sound footing is to study scientifically the species concerned. Efforts should be made to thoroughly investigate their bionomics, charter the grounds on which they flourish, study their breeding seasons, life-histories, migration and several allied problems. That even elementary principles for safeguarding the industry are ignored at present can be judged from the fact that intensive fishing is sometimes carried on even during the season when the females are breeding and it is by no means uncommon to see females in berry being openly sold in the markets. In countries where these fisheries are run on scientific lines this state of affairs could not be tolerated. In the Union of South Africa, for instance, not only is the capture and sale of any female crawfish in berry prohibited by a proclamation, but even the purchase and possession of such animals is illegal. Protective measures will have to be strictly enforced in India also, but to be useful and effective they must be based on a scientific study of the species concerned.

Spasmodic efforts have been made in the past by some Local Governments to study some of the problems connected with fisheries, but they have had very limited benefit towards the permanent improvement of the industry. Unfortunately all these efforts have not always been in the right direction; for instance, in the words of Annandale,[6] several years ago "when the Government of Bengal wished to prospect the marine fishery of the Bay, they got out a steam-trawler fitted for work in the North Sea and the Arctic Ocean." Ventures like this are seldom successful, and any little progress that has been made is chiefly due to the unceasing efforts of some of the Fisheries Departments. Probably the best organised Fisheries Department in India at present is that of the Madras Government and the successive Directors of this Department have done very valuable work for the improvement of the fishing industry in general; that connected with crabs and prawns also has been receiving a certain amount of attention. In a country like India, however, with vast coastal and inland fisheries several departments like that at Madras are needed. But as the fundamental problems of fisheries are everywhere more or less similar, some central co-ordinating organisation could make the work of these departments considerably easier and lighter by taking up some of the important scientific problems connected with their work. If a body like the Imperial Council of Agricultural Research could be induced to extend its activities to the investigation of some of these problems, a great deal of good would be done to this struggling, but potentially very valuable, industry.

[6] Annandale, "A Naturalist's view of the Chilka Lake", *Calcutta Review*, 1915, p. 14.

Lithium Fluoride as Lens Material.

PROF. Donald C. Stockbarger of the Massachusetts Institute of Technology announced before the recent meeting of the American Physical Society in Baltimore the preparation of optically perfect lithium fluoride crystals, over 3 inches in diameter. This discovery is considered to constitute a very important development in the field of optics.

Lithium fluoride crystals possess the ability to transmit light waves from high in the infra-red region, through the visible band and extending into the invisible ultraviolet region. This range of transmissibility is not possessed by any other known substance. According to a staff correspondent of the *Christian Science Monitor* (November 30, 1935), Prof. Stockbarger, at the meeting of the American Physical Society, produced motion picture reels showing his laboratory work.

The lithium fluoride is first powdered, then melted in a platinum crucible in a specially designed electric furnace provided with a device for temperature control. After the fluoride has melted, the melt is seeded with a tiny crystal of lithium fluoride and the cooling is allowed to take place slowly. Lithium fluoride crystallises in cubic formation and can be cut and polished easily.

Fruit Growing in the Plains.

By K. C. Naik, B.Ag. (Bom.), M.Sc. (Bristol).
(*Superintendent, Fruit Research Station, Kodur.*)

ALTHOUGH fruit growing in the plains has been practised from time immemorial, it is only very recently that, as a commercial industry, it has begun to make an appeal to the rural classes in this Presidency. The phenomenal success achieved in the development of fruit industry in other parts of the world, the recently accumulated scientific evidence on the valuable dietetic qualities of fruits combined with the general post-War depression in the price of the agricultural produce, have been to a large extent responsible for inducing the agricultural classes to take up commercial fruit growing in right earnest. The few pioneer attempts that have been made here and there in the Presidency have stimulated this desire by demonstrating the fact that fruit growing, if carried on properly, is one of the most paying agricultural professions.

In recent years, it has been the good fortune of some of the fruit growers of the Kodur Firka to get an annual income of over a thousand rupees per acre from citrus growing. Such huge profits have, no doubt, served as an incentive for the rapid extension of acreage under this fruit in several parts of this Presidency.

The Government of Madras have fully realised the importance of giving an impetus to this industry for a long time past. Thanks to the Imperial Council of Agricultural Research, who generously made a grant of about Rs. 66,000 spread over a period of five years, the Government of Madras have now been able to give a practical shape to its desire of furthering the industry by the starting of this Research Station in the centre of an important Citrus and Mango Belt of this Presidency. The above grant was supplemented by the Madras Government to the tune of Rs. 12,000 towards the cost of land. The sanctioned scheme includes a recurring annual grant of Rs. 3,500 towards working expenses besides, pay and allowances of staff and a non-recurring grant of Rs. 8,656 towards buildings, Rs. 3,000 for fencing, Rs. 600 for livestock and Rs. 4,000 towards other miscellaneous requirements.

The Fruit Research Station at present comprises an area of about 50 acres, and in addition to the Superintendent, it has a staff consisting of a Farm Manager and a fieldman. Although the land was taken possession of on 1st March 1935 the actual research work can be said to have commenced in the beginning of August 1935 when the Superintendent took over charge of the Station. Though the aim of the Station is to tackle problems involving all aspects of fruit growing, it is manifestly impossible to do all this simultaneously for various obvious reasons. Among the major problems to be dealt with, are the introduction and trial of almost all the varieties of citrus, mangoes and other fruits of proved merit and of acknowledged importance in the fruit trade, with a view to find out the most suitable and commercially profitable ones to the region. Side by side, a comprehensive scheme of experiments on the cheapest and most convenient methods of raising trees with the ultimate object of stocking our gardens with healthy, vigorous, precocious and most productive trees, budded or grafted as the case may be on most desirable stocks, are proposed to be taken up. Every fruit grower realises the very great importance of this work, for, the selection of stocks and method of propagation make all the difference between failure and success in the case of permanent crops like fruits, particularly because of the fact that the result of the defective nursery practices would become evident only six to eight years after planting.

Besides these, it is well known that there are other problems like cultivation, manuring, irrigation and disease and pest control of fruit trees with which the fruit growers are at present almost entirely in the dark, as is evidenced by the marked variation in the orchard practice from place to place. The research station aims at standardisation of such practices and impart knowledge of practical value in all these various aspects of fruit culture.

There is another aspect in which the fruit growers are at present greatly handicapped and that is the purchase of reliable nursery plants. Without dilating much upon this important phase it may however be stated that the failure of many gardens all over the Presidency is in a large measure due to planting of useless trees of unknown parentage, sometimes supplied even under wrong names. The Research Station wishes to solve this difficulty by arranging to supply, if possible, reliable plants of known parentage propagated from trees of proved merit.

These problems are also intimately connected with the proper nomenclature and classification of fruits—a subject on which there exists at present very great confusion and therefore needs to be dealt with exhaustively.

Food Investigation.

THE report of the Food Investigation Board for 1935 (His Majesty's Stationery Office, 4 *sh.* net.) contains a number of items of general and scientific interest. Amongst them may be mentioned the successful experimental shipments of chilled beef from New Zealand, stored in air enriched with carbon dioxide. This method enables the chilled beef to be stored from 60 to 70 days. With regard to fruit storage, the value of iodised paper as a wrapping material has been demonstrated. The method delays the development of fungi which cause rotting by considerably retarding the growth of the germ tubes. It can be employed without impairing the flavour, for grapes and other fruits, but as yet the method is unsatisfactory with peaches and some varieties of plum.

It has been found that the concentration of Vitamin C in an apple increases as the skin is approached and is six times as great in the peel as in the region of the core. In the variety "Bramley's seedling", it was found that the rosy apples had more than twice the vitamin potency of those with green skins. Canning appears not to impair the vitamin activity to any great extent and successful results have been obtained in the addition of synthetic Vitamin C to tinned products such as spinach and runner beans which do not naturally contain it.

—*Science Progress*, 1936, **30**, 521-22.

Relativity and the Expanding Universe.*

By Prof. A. C. Banerji, I.E.S., *Allahabad*.

APPEARANCES are deceptive. Stars appear as mere points of light but we know that they are great radiant orbs much bigger than our earth. A piece of copper appears to be a perfectly continuous body, but we know now that it consists of millions of molecules none of which is in contact with others. The whole progress of Science is a continual discovery that things are not what they seem. A penny may appear to be a circular disc to an observer when seen from one point of view, whereas it may look like a very narrow rectangle when seen from a different point of view. But both these observations are consistent with the conception of a penny as a three dimensional object, *i.e.*, a very short cylinder. Science really tries to reconcile different observations of every normal person.

Time, we say, goes on quickly when we are pleased or excited, and slowly when we are bored. Then we are able to draw a distinction between psychological time which is qualitative and is measured by our sensations and the clock-time which is quantitative and is used in physical science. In actual life time is filled with qualitative values. Lines of Scott express this fact very well :—

"One crowded hour of glorious life
Is worth an age without a name."

Time and space are inter-connected. We do not perceive points of space or instants of time—we perceive point-instants or events. One may say that the top of the Muir College Tower, (Allahabad), which we perceive is a definite point of space. It may be definite with respect to a set of axes, say, in Allahabad Station, but these axes are moving with the earth which is moving round the Sun which is itself in motion with respect to the so-called fixed stars and so on. So we cannot determine the height of the top of the tower without bringing in time. An event has both a place and a time and is not completely specified unless its place and its time are stated. A historian has, perhaps unconsciously, got this notion when he says "Battle of Plassey, 1757". Here he is specifying an event completely for he indicates the place (Plassey) and the time (1757). Similarly, he says "Battle of Waterloo, 1815".

We have no knowledge what is the same place at two different times nor can we find out what is the same time at two different places. There cannot be any absolute simultaneity of time or space. We can imagine that on a still day we have two soundless motor boats, side by side just in the middle of a straight canal. Although the two boats happen to be side by side at a given moment, one is supposed to be at rest and the other is moving rapidly. Now at the same instant shrill whistles are blown at each end of the canal. The observer on the stationary boat hears the whistles simultaneously whereas the observer on the other boat hears that whistle first towards which he is moving. So we conclude simultaneity of sounds depends on the velocity of the observer.

From the Michelson-Morley Experiment, two conclusions are possible, either the earth is at rest or the measure velocity of light is independent of the velocity of the man who measures it. The second possibility is a novel one and is contrary to old Newtonian conceptions of absolute rest and absolute measurement of length. Astronomers show by very powerful evidence that the earth is not at rest, so we are left with the second alternative, however strange it may appear. In *Adventures of Sherlock Holmes*, Holmes in explaining his method of getting at the truth to his friend Watson says, "It is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth."

We are then compelled to discard our notions of absolute rest and motion. Objects which appeared independent of the observer are now seen to be subjective taking a form and content determined by their relation to him. They cannot have the independent and separate property of being large or small, quick or slow, heavy or light. If time and space of an event are measured separately these separate measurements will differ with different observers. But the simple combination of them in the form (square of space measurement)—(square of time measurement) both being expressed in certain defined units, is found to be the same for all observers. Suppose an aviator travels with uniform speed in an aeroplane from Allahabad to Calcutta, and measures the distance between the two places and times the journey by his watch. Suppose also that an observer gets on the top of a very high tower from which he is able to see both Allahabad and Calcutta, and he measures the distance between these places and the time occupied by the journey. We shall find that separate measurements of both time and space will differ—although imperceptibly—and we suppose also that instruments are so delicate that these differences can be observed. But if each of the observers subtracts the square of the time measurement from the square of space measurement the results would be identical. So if we square the distance from Plassey to Waterloo and subtract this quantity from the square of the time interval between the years 1757 and 1815, the result will be the same whether the observer is on the Moon or Jupiter or on a possible planet of Star Antares.

Nature is a continually renewed body of events in a four dimensional continuum in which both space and time are inter-connected. The name Relativity given to the new theory embodying the above notion is rather a misnomer. It is true that space and time are relative, but there is also an absolute quantity—the event. This is the principle of "Unique Absolutism". It rather exalts the "Absolute" and dethrones "Relative". Event was so long relative as it depended separately on space and time. It is now *absolute*.

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* Summary of Extra-mural lecture, *Allahabad University*. By Prof. A. C. Banerji, I.E.S., M.A. (Cantab.), M.Sc. (Cal.), F.R.A.S. (Lond.), F.N.I., Allahabad, Dec. 1935.

Mathematicians have postulated that three kinds of space may be possible—*viz.*, Euclidean, hyperbolic and spherical (Riemann). Propositions in hyperbolic geometry or Riemannian geometry can be translated into analogous propositions in Euclidean space. So if there be no inconsistency in Euclidean geometry, there will not be any inconsistency in the other geometries. This is what is called by Poincaré as "the dictionary method of proof". A simple analogy between French and English may make the point clear. Any idea capable of being expressed in English can equally be well expressed in French—we cannot say one language is more perfect than the other. Similarly, we cannot say that Euclidean geometry is more perfect than the Riemannian geometry. Each is self-consistent and is found to be within limits of our empirical observations, but when we have to explain astronomical phenomena we find that Riemannian geometry suits us better. In accordance with Einstein's theory of Relativity, matter is responsible for curvature of space dimensions. Space if there be matter inside it bends round until it closes up.

Initially gravitation balanced repulsion, but it was an unstable condition. A slight disturbance must have caused the original space (containing matter) or the universe to contract or expand. Eddington and Lemaitre maintain that the universe is expanding. The spectrum of a star or a nebula has got a number of dark lines which are found to be shifted from their proper positions when compared with light from terrestrial sources. In most of the nebulæ the shift is towards the red end of the spectrum and the light emitted by a nebula when it reaches the earth has larger wave-length and smaller pitch than the normal. It is a matter of common observation that the sound emitted by a motor car horn becomes lower in pitch when it is receding from us than when it is coming towards us. So it is a possible explanation that the nebulæ are receding from us. It is also found that the velocity of recession of a nebula is proportional to its distance from us. So we may have been originally bounded in a nutshell, but as the universe is steadily increasing we may rightly think that we are gradually conquering infinite space.

Other explanations may be possible for the shift of spectral lines, some of these theories are more novel and more grotesque than the theory of expanding universe. We are not really in a position as yet to know the exact truth.

An astrophysicist can verily be compared to a blind man seeking for a black cat in a dark room that is not there. The present position of a scientist may be summed up as follows:—

"Nature and Nature's laws lay hid in night
God said, 'Let Newton be' and all was light
But not for long. The devil howling 'Ho'!
Let Einstein be, restored the *status quo*,
For how long? the sceptic smiling ask
No answer comes, Nature puts on her mask."

Chemistry in Modern Warfare.*

By Sir Martin Forster, F.R.S.

THERE are so few fundamental phases of twentieth century war into which chemistry does not enter, that it is unhappily permissible to define modern warfare as chemistry applied to the destruction of life and property. The principal factors in such warfare, other than the human beings who use them and are destroyed by them, are propellents, high explosives, detonators, poison gases, screening smokes, toxic smokes, incendiaries and gas masks.

A successful propellent must produce a relatively large volume of gas in an orderly and progressive manner, this purpose being best fulfilled by cordite which began to supersede gun-powder nearly fifty years ago. Cordite is a tough, amorphous, waxy solid produced by compounding the trinitrates of cellulose and glycerol (better known as gun-cotton and nitro-glycerine respectively) with vaseline, acetone also being used to facilitate incorporation. Gun-cotton being a trinitric ester of cellulose is a chemical step-sister of artificial silk in one of its forms, namely, acetylcellulose.

The most commonly used high explosives are picric acid (formerly called lyddite) and trinitrotoluene, familiarly known as T.N.T., the former is obtained from phenol (carbolic acid) by nitration, and as the quantity of carbolic acid obtainable from the purification of illuminating gas was inadequate when the Great War began, phenol came to be manufactured in large amounts from benzene. T.N.T. is obtained by the same process (nitration) applied to toluene, a new source of which was found in Borneo petroleum. Both picric acid and T.N.T. are yellow solids; they are melted and poured into the shells where they are detonated by mercury fulminate.

The sudden demand for cordite, picric acid and T.N.T. caused by the outbreak of the Great War led to a corresponding demand for nitric acid, and a far-reaching consequence, immeasurably important because it unhappily lengthened hostilities by two or three years, was the manufacture of nitric acid from air nitrogen by the German chemists. Before the War, the principal source of nitric acid was Chile saltpetre, and when the naval blockade deprived Germany of this material it was found that the accumulated stock in that country would be consumed before the close of 1915. Further attack on the allies must then have ceased. Confronted by this quandary, German chemical resource displayed itself in dauntless measure. Already there were known several ways by which inert atmospheric nitrogen could be fixed, the principal ones being the arc process of Birkeland and Eyde, and the catalytic process of Haber. The former required unlimited electric power in which Germany was deficient, so the Haber process by which nitrogen is combined with hydrogen to

* Summary of a lecture delivered on 10th January 1936 in Bangalore (University Extension Lecture, University of Mysore).

form ammonia, came to be adopted. Ostwald had shown how ammonia may be catalytically oxidised to nitric acid, so by linking the Haber and Ostwald processes Germany provided herself with the vast quantities of nitric acid required for continuing the war.

Coming now to the so-called poison gases, it will be appropriate briefly to comment on the history and ethics of gas-warfare. In the first place it will have been observed that it is erroneous to imagine that the term chemical warfare applies only to gas-warfare. All modern warfare is chemical warfare and gas-warfare is only one aspect of it. Moreover, the idea at least and to some extent the practice of gas-warfare is by no means new. The Spartans, earlier than 400 B.C., used sulphur dioxide, and similar use of poisonous gases was made in the Middle Ages. During the Crimean War (1853-56) it was proposed to use sulphur dioxide against the Russians, but the British Government of the period rejected that plan on the ground of humanity. At the Hague Congress of 1907 it was expressly forbidden to use poisons or poisonous weapons in war.

It was therefore a complete and overwhelming surprise when, on April 22nd, 1915, the Germans launched their first gas attacks using chlorine projected from pressure-cylinders containing the liquefied gas. It occurred on the north-west part of the Ypres salient, and the effect was disastrous. A breach, both deep and wide, was made in the Allied line, and had the Germans been ready to follow up their advantage the result might have had a rapid and permanent effect on the course of the War: but happily they surprised themselves as well as the Allies, and the only permanent effect was adoption of reprisals. In May 1915, it was decided to organise a gas service which became effective in September and until the Armistice in November 1918 gas-warfare became an increasingly important branch of the conflict.

Chlorine was the most readily available of the poison gases, the pre-War manufacture being enormous owing to its use in the manufacture of bleaching powder. Moreover, it is the foundation material of other poison gases, of lachrymators and sternutators, while conversely it was used for sterilising the drinking-water required by the armies. Following chlorine there came in December 1915, phosgene, a compound of chlorine with carbon monoxide. Phosgene is much more toxic than chlorine, and being chemically less reactive, protection from it is more difficult. Fortunately the British were informed beforehand of its intended use, and were therefore ready with hexamethylenetetramine in the masks.

Mustard gas (dichloroethyl sulphide) was first used in the War by the Germans at Ypres in July 1917. By this time wave-attacks had been largely superseded by shells containing the noxious materials, this being widely distributed when the shells burst. Consequently and in view of its low vapour pressure mustard gas-attacks were always made by shell. The first was another surprise, causing twenty thousand casualties in six weeks, the physiological action being disastrous and peculiar. As in the case of poisoning by phosgene, there is a latent period before any effects are noticed, the most characteristic of these being the vesicant, or skin-blistering action, which occurs from four to twelve hours after exposure to the vapour or splashes. This action is much more intense when the skin is wet than on dry skin; consequently the effects on the eyes and lungs are frightful, besides being toxic. It lingers for two or three days in the warmest weather; while in cold, damp weather it is dangerous for a week or ten days. It is only slowly destroyed in the earth, so that digging round shell-holes remains dangerous for months.

Besides the foregoing, there were used as poison-gases chloropicrin and diphenylchloroarsine (sneezing-gas), but the deadly Lewisite was elaborated only as the War closed, and was never used on the battle-front. Lachrymators, that cause involuntary weeping which leads to temporary disablement, were usually bromine compounds, *e.g.*, bromoacetone, benzyl bromide and bromobenzyl cyanide. With improved efficiency of gas-masks these diminished in importance being useful chiefly against unprotected troops.

Screening-smokes have great practical value and are produced by burning phosphorus or by launching into moist air the vapours of tetrachlorides of tin, silicon, or titanium, all of which are thus converted into the hydrated metallic oxides. Latterly came Berger Mixture (containing zinc, carbon tetrachloride, sodium chlorate, ammonium chloride and magnesium carbonate), used in the smoke box and smoke candles. Toxic smokes are screening-smokes which carry a poison-gas, diphenylchloroarsine for instance. Another type of smoke is used for signalling, and depends on volatilisation of organic dyestuffs, *e.g.*, chrysoidine, auramine and indigo. Incendiary bombs depend principally on thermite (aluminium and oxide of iron), but as its action is confined to a small area and being rapid, quickly disperses the heat-energy, thermite is used in conjunction with so-called solidified oil, *i.e.*, petroleum absorbed by soap.

Measures taken for defence against gas revealed ingenuity and resource corresponding to the demands made by complications in gas-warfare, and led finally to the box-respirator, whose essential mechanical features are: (1) an enclosed face-piece protecting the eyes and skin, (2) a flexible hose connecting this with a canister of absorbents, (3) an exhalation valve, and (4) an efficient packing of chemical absorbents in the canister. The requirements of an efficient absorbent are: (1) Absorptive activity, *i.e.*, a very high rate of absorption, (2) Absorptive capacity, *i.e.*, the material must hold large gas-volumes per unit weight, (3) Versatility, *i.e.*, protection against any kind of toxic gas, (4) Mechanical strength to resist conditions of transport and field-use, (5) Chemical stability, *i.e.*, escape from deterioration with time, and (6) Low breathing-resistance, importance of which may be realised from the fact that a normal man when exercising violently, inhales about 60 litres of air per minute. The absorbents best qualified to meet these requirements are activated charcoal made from cocoanut-shells, and soda-lime with a small proportion of sodium permanganate.

Having now surveyed some applications of chemistry to modern warfare, some remarks

may be offered on the non-technical aspect of these applications. In the first place, you will have seen that the popular use of the term "chemical-warfare" in connection only with poison-gas is erroneous: all modern warfare is chemical warfare and superiority is determined by capacity to manufacture and skilfully to apply chemical materials. In the second place, it is erroneous to regard gas-attacks as more inhumane than destruction with explosives or bayonets; probably this misconception is owing to the frightful results of such attacks on unprepared troops. After the first surprise and consequent elaboration of protective measures gas-attacks were far less destructive than bullets and explosives. This appears very clearly from the official casualty-lists of the American troops, who, coming late into the War, were fully prepared against gas. In round figures, 25 per cent. of all casualties from bullets and explosives resulted in death, while of those wounded by gas only 2 per cent. died. It is thus fallacious to blame Science for having made War, more inhumane. War is the most brutally inhumane agency imaginable and introduction of scientific methods only implies that the power commanding superior inventiveness must ultimately prevail. The famous American naval expert, Admiral Mahan, who wrote a masterly and arresting book entitled "The Influence of Sea-Power upon History" was an American delegate at the Hague Conference of 1899, when several of the more prominent nations of Europe and Asia, including Germany, pledged themselves not to use projectile whose only object is to liberate suffocating or poisonous gases. The United States never signed the declaration, and Admiral Mahan stated his position in these words:

"The reproach of cruelty and perfidy addressed against these supposed shells was equally uttered previously against fire-arms and torpedoes, although both are now employed without scruple. It is illogical and not demonstrably humane to be tender about asphyxiating men with gas, when all are prepared to admit that it is allowable to blow the bottom out of an ironclad at midnight, throwing four or five hundred men into the sea to be choked by water, with scarcely the remotest chance to escape."

The subject needs clear thinking. To me, the criminal aspect of poison-gas lies in breaking the agreement not to use it.

The Place of India in Pre-History.*

THOUGH absolute dating in time is impossible in pre-history a geological chronology can be constructed, and at the time when man appeared glacial deposits were being formed in the north, while in the tropics corresponding climatological changes have resulted in deposits the relation of which to those further north is now being investigated.

The evolution of man's brain from lower to higher levels is reflected in the degree of perfection achieved in the tools he used and, as different types of tools form a sequence agreeing with the sequence of geological strata, they afford the best available evidence of the course of human evolution during the early Ice Age, human fossils being fragmentary and very rare.

In Europe the most primitive tools are called Eoliths or "dawn stones". From these tools, which are so crude as to be scarcely recognisable as such except to a trained eye, the sequence passes through successive stages of finer and finer workmanship in the process of flaking by which they were made, to more useful artifacts upto those of the Neolithic Age of polished stone which in its turn passed into the metal era. Each stage —Chellean, Acheulean, Mousterian, etc.—is named after a type station in Europe, and such cultural stages are well defined and easily recognisable. But the evolution was not smooth, for in Europe two civilisations are found to have alternated, fluctuated and finally merged as the peoples respectively advanced and dominated or fell behind, till at last they were assimilated the one into the other. The first of these groups is called the Core Tool People since they generally used as implements stone cores shaped by the striking off flakes. The second is called the Flake Tool People, since they used as implements flakes struck off from a core — a difference in method of manufacture involving a fundamental difference in psychology. It seems likely that the Flake peoples of Europe were invaders from Asia and the Core peoples from Africa. The Mousterians were probably a mixture of the two, though there were later invasions from Asia during Upper Palæolithic and Neolithic times.

A somewhat similar history can be traced in Africa. But there the core technique was definitely dominant while the flake technique did not gain much hold except in the north, where Asiatic influence would be more readily felt. In China, on the other hand, all cultures so far studied are flake cultures, the earliest being rather Mousteroid in form but of a coarser type, though lately a core-pebble culture similar to that found in North India has been reported.

The special importance of India for the proper interpretation of the facts of pre-history lies in her position in the geographical centre for Europe, Africa, China and Java, as well as in the many artifacts known to occur there and in the Primate remains of the Siwalik deposits which give grounds for hope that humanid remains may eventually be found there also, especially in view of the hypothesis put forward by physical anthropologists that the strenuous climatic conditions resulting from the uplift of the Himalayas were deciding factors in human evolution.

Research in India is also needed to throw light upon the origin of the Asiatic invasions of Europe in Aurignacian and Neolithic times, for it is in India that the earliest proto-Neolithic tools of Asia seem to occur; while the apparent absence of true Asiatic flake cultures from India also calls for further investigation. Though Asia may open the door to a true concept of the pre-history of man, India holds its key.

* A brief summary of the lecture delivered by Mr. T. T. Paterson of the Yale-Cambridge India Expedition, on Thursday, November 28, under the auspices of the Archæological Society of South India, Madras.

Science Notes.

New Year Honours.—The names of the following men of science are included in the list of the recipients of the New Year Honours :—

KNIGHT BACHELOR : Mr. B. C. Burt, Officiating Chairman of the Imperial Council of Agricultural Research.

O. B. E. : Dr. S. S. Bhatnagar, Director of the University Chemical Laboratories, Punjab University.

C. I. E. : Dr. C. C. Inglis, Superintending Engineer, Deccan, Bombay ; Mr. R. S. Allan, Director of Agriculture, U. P.

SARDAR BAHADUR : Rai Saheb Subedar Mula Singh, I.O.D., I.M.D., First Asst. to the Director of Nutritional Research, I.R.F.A., Coonoor.

KHAN BAHADUR : Mian Muhammad Afzal Husain, Principal, Punjab Agricultural College, Lyallpur.

RAI BAHADUR : Babu Saharda Kanta Ganguli, Professor of Mathematics, Ravenshaw College, Cuttack ; Rai Sahib Kumarnath Bagchi, Chemical Analyst to the Government of Bihar and Orissa, Public Health Department, Patna.

RAO BAHADUR : Mr. S. Sundara Raman, Government Mycologist, Coimbatore ; Mr. Vinayak Atmaram Tamhane, Officiating Chief Agricultural Officer in Sind ; Rao Sahib Y. Ramachandra Rao, Locust Research Entomologist, Imperial Council of Agricultural Research.

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Assamese Coins.—At the ordinary meeting of the Asiatic Society of Bengal, held on Monday, 6th January, Mr. H. E. Stapleton presented a paper entitled "*The Countess Amherst Collection of Assamese Coins*".—"In July 1934, Sotheby and Co., London, advertised for sale, among other lots, a collection of 12 Gold and 72 Silver coins which were listed as 'the Countess Amherst Collection of Assamese Coins'. A Ms. description of these coins by Dr. Horace Hayman Wilson, Secretary of the Asiatic Society of Bengal from 1811-1833, was included in the lot, from which it appeared that this collection was probably made shortly after the first Burmese War of 1824-6 at the instance of the then Governor-General, Lord Amherst, who was created Earl Amherst of Arakan after the conclusion of the War. It seems likely, from Dr. Wilson's note of 1828, that the agent employed by Lord Amherst was Capt. Neufville, Intelligence Officer during the War, and, later, Commandant of the Assam Light Infantry."

Mr. Stapleton was able to purchase the collection on behalf of the Government of Assam. Examination showed that it included at least 10 gold and 38 silver Assamese coins that were new to the Provincial Cabinet at Shillong. The coins which have been figured in the plates accompanying the paper are : Half and Quarter rupees of Siva Simha and Queen Ambika; $\frac{1}{2}$-rupee of Rajeshvara in Nagri script; two rupees of Gaurinātha with curious dates; $\frac{1}{4}$-rupee of Bharatha; Mohur of Brajanātha of 1740 *Sakā*; and finally, a $\frac{1}{4}$-rupee of Jogeshvara of 1740 *Śakā*. These coins have not been previously described.

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Discovery of the complete skull of a primitive carnivore, a flesh-eating mammal about the size of a cat, which lived in the lower Paleocene Epoch about ninety million years ago, has been announced by Dr. Glenn L. Jepsen of Princeton University. The skull was found by the 1934 Scott Fund Expedition, of which Dr. Jepsen was the Chief Director, in the Big Horn Basin of Wyoming about 25 miles north-west of Cody. With the exception of specimens uncovered by the 1935 expedition, which have not as yet been studied, it is believed that this is the only complete skull of the earliest known primate, the order to which monkeys, apes and man belong.—(*Science*, Nov. 22, 1935, *Supp.* 8.)

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South Indian Bronzes at South Kensington.—It is announced that, by a bequest of the late Lord Ampthill, former Governor of Madras, the Victoria and Albert Museum, South Kensington, has recently acquired five bronzes of the members of the Hindu Pantheon, which are both of high artistic merit and of interest for their religious significance. The most important of these is a figure of Siva, the Cosmic Dancer, which symbolises God as both performer and audience in the universe as his stage. The figure bears all the marks that are usually attributed to Siva by the Hindus. These figures were found buried near a temple in the Tinnevelly District of the Madras Presidency. They were made by the *cire perdue* process ; and from their stylistic affinities, it is concluded that they belong to the late tenth or early eleventh century of our era. A number of other objects of great interest illustrative of Brahmanical and Buddhist beliefs have been bequeathed to the Museum by Lord Ampthill. —(*Nature*, 1935, **136**, 946.)

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Study of Upper Air Circulation over India.—The Upper Air Section of the Meteorological Office, Poona, have recently published (*India Meteorological Department, Scientific Notes*, 1935, **6,** 66) wind frequencies at 4, 6, 8 and 10 km., prepared out of all available data of morning pilot balloon ascents up to the end of 1931. The data will be of help to investigators of the upper atmospheres and will also meet special aviation requirements such as occurred during the Mount Everest flight in 1933, and the England-Australia Air Race in 1934. It is practically certain that progress in aeronautics will, at no distant date, demand from meteorologists information about upper winds above 3 kms. even for routine flights.

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Report of the Building Research Board for the year 1934. (His Majesty's Stationery Office. Price 3*s.* 6*d.*)—There can be but few problems connected with building that are not at one time or another the subject of scientific investigation at the Building Research Station. The Annual Reports on the Station's activities therefore are invaluable records for those actively concerned with building, whether as architects, engineers, building contractors, manufacturers of materials, etc.

The Station receives a large number of enquiries regarding practical problems annually and an important feature of the reports is a section reviewing the enquiries dealt with during the year.

The Institute of Engineers (India).—The 16th Annual General Meeting of the Institute of Engineers (India) was held in Madras on January 7–8, 1936, with Rao Bahadur B. P. Varma, the President in the Chair. Lt.-Col. (Hon. Col.) F. C. Temple, C.I.E., V.D., was elected President for the current year.

In the course of his Presidential Address, Col. F. C. Temple dwelt on the Teaching of Mathematics; he said "the teaching of applied mathematics in the form of Mechanics, Dynamics, Statics and Hydraulics and Hydro-Dynamics should all be based on practical illustration, because it is supremely important that the Engineer should instinctively and almost subconsciously apply his knowledge to what he sees in front of him or will see when he has carried out into reality whatever he is designing."

A number of important papers were read on January 8, and there was the annual dinner when H. E. Lord Erskine along with other delegates, officials and representatives of trade and commerce were present.

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Economic Conference.—The Nineteenth Session of the Indian Economic Conference was held at Dacca on January 2, 1936, under the presidentship of Mr. Manohar Lal, M.A., Bar-at-Law. In the course of his address, he dwelt upon the present day world economic problems and the various remedies to solve them suggested by different economists. Referring to the problems of Indian Economy, he laid stress on the increasing dependence of India on agriculture and her poor industrial development, which constitutes a grave and fundamental problem, and the inadequacy of Government support to the people. Speaking on the population problem, he cited Japan as an example for India, who by building up her trade and industry effectively solved her population problem. He emphasized the necessity of perfect business organisation and stringent pursuit of sound finance in our trade and industrial policy for building up a sound economy for India. Finally, he sounded a warning note on the fast approaching fate of India maintaining her vast population on her own agriculture and struggling to buy manufactured goods from abroad at growing disadvantage. The most urgent task of the economist now is "to rouse the conscience of both the people and the Government to a consciousness of the peril towards which we are drifting and to the necessity of straining every nerve to reconstruct our economic life", by improvement in agriculture, voluntary restriction on the growth of population, and increase in industrialisation in full view of the situation in the West.

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Roads Congress.—The Second Session of the Indian Roads Congress held its Council Meeting on January 4, 1936, at the Legislative Council Hall, Bangalore, to frame a report to the Congress. Delegates from the various Indian States, Provinces, Government of India and private Engineering firms were present. Mr. K. G. Mitchell was President of the Conference.

The period from 5th to 8th January 1936 was fully occupied by the delegates in inspecting the various Engineering constructions in Bangalore, Mandya, the Tunnel Works at Hulikere, Krishnarajasagar Dam, Sivasamudram and other places of interest near Mysore. Sir Mirza M. Ismail, Kt., C.I.E., K.C.I.E., Dewan of Mysore, formally opened the Congress at Sir Puttanna Chetty Town Hall on the 9th January at 10 A.M. For three days, the delegates were busy with discussions of technical papers and the Business Session which was held on the 11th. During the spare hours on these days, they visited the Indian Institute of Science, Porcelain Factory and the Sandalwood Factory. Some of the delegates then proceeded to Kolar Gold Fields to inspect the mines.

At the preliminary meetings were discussed the Reports of the Technical and Drafting Sub-Committees and the Accounts of the Inaugural Indian Roads Congress.

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The following Sectional Presidents for the Annual Meeting of the British Association to be held in Blackpool from September 9 to 16, 1936, under the presidency of Sir Josiah Stamp, have been appointed:—Mathematics and Physical Sciences: Prof. A. Ferguson; Chemistry: Prof. J. C. Philip, F.R.S.; Economic Science and Statistics: Dr. C. R. Fay; Engineering: Prof. W. Cramp; Agriculture: Prof. J. Hendrick.

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The Royal Society.—At the anniversary meeting of the Royal Society held on Saturday, November 30, 1935, the following officers and members of council were elected:—*President:* Sir William Henry Bragg; *Treasurer:* Sir Henry George Lyons; *Secretaries:* Sir Frank Edward Smith, Prof. Archibald Vivian Hill; *Foreign Secretary:* Prof. Albert Charles Seward; *Other Members of the Council:* Prof. Edgar Douglas Adrian, Mr. David Leonard Chapman, Prof. Arthur William Conway, Dr. William Henry Eccles, Prof. Arthur Stewart Eve, Prof. Louis Napoleon George Filon, Dr. James Gray, Sir Alfred Daniel Hall, Dr. Stanley Wells Kemp, Sir Patrick Playfair Laidlaw, Sir Gerald Ponsonby Lenox-Conyngham, Dr. Gilbert Thomas Morgan, Prof. Robert Robinson, Dr. Bernard Smith, Prof. Walter Stiles, Mr. Wilfred Trotter.

Sir Frederick Gowland Hopkins, President of the Society, then presented the following medals for 1935:—*Copley Medal* to Prof. C. T. R. Wilson for his contributions to the progress of modern physics by his work on the use of clouds in advancing our knowledge of atoms and their properties; *A Royal Medal* to Prof. C. G. Darwin for his researches in mathematical physics, especially quantum-mechanics, optics and statistical mechanics; *A Royal Medal* to Dr. Alfred Harker as the greatest British petrologist since that subject became a science; *Davy Medal* to Prof. Arthur Harden in recognition of his distinguished work in biochemistry and especially of his fundamental discoveries in the chemistry of alcoholic fermentation; and the *Hughes Medal* to Dr. Clinton Joseph Davisson for his discovery that electrons are diffracted like waves of light.

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Asiatic Society of Bengal.—At the ordinary monthly meeting of the Society held on the 6th January, the following candidates were balloted for as ordinary members: (1) Lieut.-Col. Owen C. Pulley, (2) Dr. Owen Alfred Rowland Berkeley-Hill, (3) His Excellency the Rt. Hon'ble Sir John Anderson, and (4) Dr. Alfred G. Brocke.

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Stratosphere Pictures of the Earth.—During the recent record-breaking stratosphere flight over

South Dakota by Captain Albert Steven of the American Army Air Corps, a picture of the earth taken 14 miles above the world's surface has been put forward as a new proof of the earth's roundness. Still and motion pictures at 72,395 feet have been taken. The earth curvature picture shows a section of the horizon, 220 miles long, over 3½ degrees of circle, about 1/100th part of the total circumference of the earth. Still and motion pictures taken directly downwards from the stratosphere balloon, show the earth as a huge plain, marked with tiny chess board farms and fields, which details were invisible to the naked eye in the balloon.

* * *

The 200-inch glass intended for the giant American telescope was recently taken out of the mould and taken by a special train from Pasadena (California) for polishing. 20 tons of a special kind of silicate glass has been used for making it, and the molten glass was poured into the mould just a year ago. The cooling process has been officially pronounced a success. The polishing operation is expected to take five years. The new telescope will be twice the size of any other, and it is reckoned that with its aid, it will be possible to scan the regions, 1,200,000,000 light years away!

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Expedition to Mount Everest.—The names of the twelve men who, with Mr. Hugh Ruttledge as their leader, will make the fifth attempt to reach the summit of Mount Everest this year, have been announced. Nine have already participated in the previous expeditions to Mount Everest and eight are expected to be capable of reaching high altitudes, up to at least 23,000 feet. The party has been, after a detailed and rigorous examination, limited to twelve to reduce the difficulties of porterage on the glaciers and to simplify the problems of control. The names of the twelve persons selected are: Hugh Ruttledge, F. S. Smythe, E. E. Shipton, P. Wyn Harris, E. G. H. Kempson, Dr. C. B. Warren, F. H. L. Wigram, Lieut. J. M. L. Gavin, Lieut. P. R. Oliver, Major C. J. Morris, Dr. Noel Humphreys and Lieut. W. R. Smirth-Windham.

* * *

Researches conducted jointly by the Antarctic ship, "*Discovery*", the British Museum of Natural History and the London National Institute for Medical Research, show that a female sex hormone, known as progestin, and widely used in gynæcological practice, can be obtained as a by-product of the whaling industry instead of from sows killed in slaughter houses. The hormone, surprisingly enough, can be obtained under ordinary whaling conditions and can be preserved in formalin for many months. Authorities in London believe that the hormone can be produced synthetically on a commercial basis. Progestin is produced by the corpora lutea of the ovaries. Besides playing a secondary sex-stimulating rôle, it prepares the uterus for reception of the fertilised egg preparatory to pregnancy.— (*Science*, 14th Nov. 1935, *Supp.* 10.)

* * *

A Brief History of Self-Reciprocal Functions (The Journal of the Indian Mathematical Society, New Series, Vol. 1, No. 7).—Brij Mohan Mehrotra's paper serves as an explanatory introduction to the author's papers on Self-Reciprocal Functions published in various journals. Examples of self-reciprocal functions occurring in the works of various mathematicians are cited. An epitome of the results of Hardy and Titchmarsh, and of Bailey on the subject is then given. The paper concludes with a useful bibliography on the subject.

* * *

Village Sanitation and the Borehole Latrine.—Considerable doubt is being thrown on the practical utility of the Borehole latrine as a safe and convenient method of improving the sanitation of villages in India, a method about which much was expected at one time. *The Allahabad Farmer*, Vol. 9, No. 6, reports an interesting discussion at a meeting of practical rural improvement workers on some of the aspects of this method. How near the water-level is a borehole latrine safe? How near to a well can a latrine be made? How can we arrange for the periodical cleaning of the hole? The nature of the movement of soil moisture both laterally and vertically underground, the possibility or otherwise of bacterial contamination and the safety limits of distance for such have still to be studied and worked out before a satisfactory answer can be given to these questions, data from Egypt or the U. S. A. on these matters not being strictly applicable here. The study of the movements of soil moisture undertaken some years ago in Bangalore certainly indicate that there is a large lateral movement in addition to the vertical movement. Now that the matter has assumed importance from a sanitary point of view in addition to its agricultural aspect, the movement of the bacterial flora, if any, will have to be studied.

* * *

Imperial Institute of Agricultural Research.—It is learnt that Lord Linlithgow will be requested to perform the opening ceremony of the Imperial Agricultural Research Institute in its new home, close to New Delhi, early in November 1936. The Foundation Stone was laid by H. E. Lord Willingdon in February last, and the construction was taken in hand after May. The various buildings for the different sections of research will be ready by the middle of summer. It is estimated that the total cost of the buildings amount to Rs. 36 lakhs. The buildings for the Institute, Library, Laboratory, Officers' quarters, etc., occupy 300 acres and 500 acres are reserved for field experiments.

* * *

A New Fertilizer.—It is reported that, after a series of experiments, a new fertiliser known as Nitrogen Lime Phosphate has been introduced on the German market. It contains about 16 per cent. of Nitrogen (Nitrate Nitrogen and Ammonia Nitrogen in the ratio of 1 : 1), about 16 per cent. of citrate-soluble phosphoric acid and about 35 per cent. of lime in the form of both phosphate and silicate. Due to its great solubility, the new material is stated to give good results both as a top-dressing and as a sub-surface fertiliser. The silicates of lime which are present in it in the form of furnace slag are reputed to cause increase of the rigidity of the grain grown and to act as preventive to the growth of fungus.

* * *

The Preservation of Oxidisable Products.—Highly protective yellow transparent cellulose films have been developed in the United States for the protection against rancidity of foodstuffs

and other organic bodies. It has been established by systematic exposure tests that the blue and invisible portions of the Solar spectrum are the main accelerators of rancidity, and that many of the coloured transparent wraps that have been introduced hitherto have failed in their purpose in that they did not completely filter out the blue and ultra-violet radiations. The new product in sheeting 0.001-inch thickness is claimed as being completely opaque to ultra-violet light while possessing a very high transparency. The utilisation of the sheeting is also proposed for preventing the decomposition of hydrogen peroxide, and for avoiding the discolouration of such products as phenol, aniline oil, quinine sulphate and calomel. It is also suggested that it can be used as a wrapping material for packaged flavours, perfumes and toilet soaps.—(*The Chem. Trade Jour. and Chem. Engineer*, 1935, **97**, 470.)

* * *

The Symons Gold Medal for 1936 of the Royal Meteorological Society has been awarded to Prof Wilhelm Schmidt, Director of the Central Institution for Meteorology and Geodynamics, Vienna. This medal is awarded biennially in recognition of distinguished work in the field of meteorological science.

* * *

The Perkin Medal has been awarded to Dr. Warren K. Lewis of the Massachussets Institute of Technology. The medal is awarded annually for outstanding work in applied chemistry.

* * *

The Permanent International Committee of Congresses of Genetics, which was constituted at the Sixth International Congress of Genetics held at Ithaca, New York, 1932, has accepted the invitation of the Academy of Sciences of the U. S. S. R. to hold the Seventh International Congress in Moscow and Leningrad in 1937. At about the same time, the All-Union Agricultural Exhibition will be held in Moscow thus making the occasion unique.

* * *

The 12th International Acetylene Congress will be held at Caxton Hall, Westminster in June 1936. H. R. H. the Prince of Wales has consented to lend his name as Patron of the Congress. Dr. J. Donald Pollock and Mr. P. B. Liversidge of the British Oxygen Company, Ltd., have accepted the offices of President and Vice-President respectively. Further information may be obtained from the General Secretary, 12th International Acetylene Congress, 639, Grand Buildings, Trafalgar Square, London, W. C. 2.

* * *

It is announced in *Science* that the date of the third International Congress on Malaria has been postponed until the spring of 1936. Further information can be had from Prof. G. Pittaluge, Director of the National Institute of Health, Calle de Recoletos, 20, Madrid.

* * *

The International Union of Geodesy and Geophysics will meet at the University of Edinburgh from September 15 to 26, 1936.

* * *

It is announced in *Nature* that the fourth International Congress of Cytology will be held in Copenhagen in 1936, probably in August. Further information can be had from the General Secretary, Nassaustrasse 17, Berlin-Wilmersdorf.

The first International Congress of Criminal Anthropology and Psychiatry will be held in Rome in April 1936. Etiology, diagnosis and prognosis of criminality in minors; prophylaxis of crime in relation to penal laws; criminal biology and anthropology, etc., will be some of the subjects to be discussed. Further information can be obtained from the General Secretary, Prof. B. di Tullio, via Giulia 52, Rome.

* * *

Recent Publications.—Scripta Mathematica Library: "Poetry of Mathematics and Other Essays," by Professor David Eugene Smith. 96 pages. Price 75 cents. "Mathematics and the Question of Cosmic Mind, with Other Essays," by Professor Cassius Jackson Keyser. 128 pages. Price 75 cents. "Mind, the Maker: The World Theory of the late William Benjamin Smith." Presented by Professor Cassius Jackson Keyser. 32 pages. Price 35 cents.

* * *

It is announced that the third International Congress of Comparative Pathology will be held in Athens from April 15 to 18, 1936, under the presidentship of Prof. W. Bensis of Paris.

* * *

ANNOUNCEMENTS.

Third Course of Instruction in Malariology.—The Health Committee of the League of Nations is arranging for a Third Course of Instruction in Malariology which will commence at the King Edward VII College of Medicine at Singapore on 27th April.

There will be three distinct stages to each course.—(1) A preliminary revision course for 4 days from 22nd April 1936, for candidates with a limited experience of the subject; (2) Theoretical and laboratory studies with practical demonstrations lasting from 27th April to 30th May; and (3) The practical field studies commencing at the beginning of June, for which the candidates will be divided into groups, one of which will study in Malaya, one in French Indo-China and probably another in Java. This occupies about 21 days by which time the students are expected to become familiar with the routine of a malariologist and the actual application of anti-larval and other anti-malarial measures to field conditions.

The League of Nations is making available a limited number of partial fellowships to candidates nominated by their Governments on condition that their Governments bear half the cost. The subscription for the theoretical and laboratory course will be 75 Straits dollars. Any further information will be supplied by the Director of the Eastern Bureau of the League of Nations, 336, River Valley Road, Singapore. Applications for admissions should be addressed to the above address so as to reach Singapore before 29th February 1936 and as only 30 candidates are admitted, early application would be advantageous.

* * *

Reward of £ 5,000 for a Practicable Method of Eradicating Skeleton Weed.—The following taken from the *Agricultural Gazette of New South Wales, Australia*, Vol. 46, Pt. 7, will be found interesting and, let us hope, profitable to readers of *Current Science*. A reward of £ 5,000 is being offered for a practicable method—mechanical, cultural, biological or chemical—of completely eradicating mature and seedling plants of Skeleton Weed.

The offer is subject to a number of terms and conditions, which can be obtained from the Department of Agriculture. The suitability, practicability and efficacy of any method submitted and the question whether the prescribed conditions have been complied with shall be determined by a committee which shall be appointed by the Minister for Agriculture, whose decision shall be final. Applications for the reward will be received by the Minister for Agriculture, up till 1st July 1937.

We may add that the botanical name for what is called "skeleton weed" in the above is *Chondrilla juncea*. The characters of the plant appear various and it is known under a number of specific names such as *C. lacinata*, *C. intybacea*, *C. lutea*, *C. latifolia*, *C. viscosa*, *C. rigens*, and so on.

While on this subject we may also remind readers that a similar reward awaits nearer home, *viz.*, the reward promised by the Government of Mysore for a suitable remedy for the spike disease of sandal announced some twenty-five years ago which, so far as we know, has not been withdrawn nor been claimed and won by anyone.

* * *

We acknowledge with thanks the receipt of the following:—

"Agricultural Gazette of New South Wales," Vol. XLVI, Pt. 12.

"Journal of Agricultural Research," Vol. 51, No. 4.

"Journal of Agriculture and Livestock in India," Vol. V, Pt. VI, November 1935.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4331–4333.

"Indian Journal of Agricultural Science," Vol. V, Pt. V, October 1935.

"Journal of the Annamalai University," Vol. V, No. 1, November 1935.

"Biochemical Journal," Vol. 29, No. 11, November 1935.

"The Journal of the Indian Botanical Society," Vol. 15, No. 1, January 1936.

"The Journal of the Institute of Brewing," Vol. XLI, No. 12, December 1935.

"Canadian Journal of Research," Vol. 13, Nos. 4 and 5.

"Chemical Age," Vol. 33, Nos. 856–859.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 12.

"The Journal of the Indian Chemical Society," Vol. 12, No. 11, November 1935.

"Forschungen und Fortschritte," Vol. 11, Nos. 34, 35, 36.

"Monthly Statistics of the Production of Certain Selected Industries of India," July and August 1935. (Department of Commercial Intelligence and Statistics, India.)

"The Philippine Agriculturist," Vol. 24, Nos. 1 to 7.

"Scientific American," Vol. 153, Nos. 5 and 6.

"The Review of Applied Mycology," Vol. 14, Pts. 2–11.

"Transactions of the Faraday Society," Vol. 31, Pt. 12, December 1935.

"Report No. 12 from the Fisheries and Marine Biological Survey for the year ending December 1934," South Africa.

"Quarterly Bulletin of the Health Organization," Vol. 4, No. 3, September 1935. (League of Nations, Geneva.)

"Department of Commerce and Industries—Fisheries and Marine Biological Survey Division, South Africa, Investigational Report," No. 5.

Indian Central Cotton Committee Technological Laboratory, Technical Leaflet No. 5, November 1935.—"The Influence of Method of Picking on the Quality of Cambodia Cotton."

"The Lenin Academy of Agricultural Sciences in U.S.S.R.," August 1935.

"Marriage Hygiene," Vol. II, No. II, November 1935.

The Punjab Irrigation Research Institute—"Report for the year ending April 1935."

"Nature," Vol. 136, Nos. 3447–3450.

"The Journal of the Bombay Natural History," Vol. 38, No. 2, Index and Title-page, Vol. 37, Nos. 3 and 4.

"The Journal of Nutrition," Vol. 10, No. 5.

"Journal de Chimie Physique," Vol. 32, No. 9.

"The Indian Trade Journal," Vol. CXIX, Nos. 1540–1541.

CATALOGUES.

"Catalogue of Books of Messrs. John H. Knowles on Agriculture, Botany and Zoology," No. 22, 1935.

"Neuere Chemische und Physikalische Werke," November 1935.

"Verzeichnis der Werke und Zeitschriften" (Akademischen Verlagsgesellschaft, M.b.H., Leipzig).

Indian Obstetric and Gynæcological Congress.

THE first All-India Obstetric and Gynæcological Congress was held at Madras on the 2nd, 3rd and 4th January 1936, under the distinguished presidency of Dr. Ida Scudder, M.D., D.SC., F.A.C.S. His Excellency Lord Erskine, G.C.I.E., the Governer of Madras, inaugurated the session. Rao Bahadur Dr. A. Lakshmanaswami Mudaliar, M.D., F.C.O.G., Chairman of the Reception Committee, extended a very hearty welcome to the vast and representative assemblage of delegates to the Congress.

Being the first sessions of the Congress a greater portion of the Presidential Address naturally dealt with its aims. The President said "As an outcome of this Congress," which is a fruition of the conjoint efforts of the Bombay Obstetrical Society and the Obstetrical and Gynæcological Society of Madras and S. India, "research should be stimulated and with this end in view we should encourage the establishment of an Indian Obstetrical and Gynæcological Journal ...." The President then proceeded to discuss methods of coping with the many-sided obstetric problem of the Indian villages a subject which he has pursued with ardour for over three decades. The large infantile and maternal mortality to which His Excellency adverted in his inaugural speech, was greatly due to the ignorance of the lay public that needed education to avail of the modern methods of obstetrical practice. In this direction the young medical practitioner had a duty to perform in

disseminating knowledge amongst and bringing relief to the superstitious and suffering villagers. There would thus arise the necessity for the establishment of a central organisation with powers to control and supervise all obstetric and gynæcological work in the country. Such an organisation, with the co-operation of the different Local Bodies, would alone lead to rural upliftment in maternity and child-welfare.

In the welcome address, delivered earlier by the Chairman of the Reception Committee greater emphasis was, however, laid on the need for research in our country in obstetrical and allied problems. And, as for the means to carry on such research, the Chairman remarked, "May we not hope that an appeal from this Congress and through Your Excellency to the generous public will not fail to evoke a sympathetic response? May we not also hope that various administrations in British India and Indian India will co-operate in a spirit of healthy rivalry to organise and support all such laudable enterprise?"

About fifteen papers pertaining to obstetrics and gynæcology were read and discussed during the session. Of these, the papers read on the last day were particularly interesting devoted, as they were, mostly to problems of post and anti-natal care, causes and prevention of infantile mortality, and of child-welfare in general. There were two debates, one on "Pelvic Disproportions" and the other on "Displacements of the uterus". Mrs. Margaret Sanger gave an evening lecture on "Contraception".

A noteworthy feature of this Congress was an exhibition, displaying medical and surgical goods used in obstetrical and gynæcological practice, infant foods and milk products, patent medicines and drugs.

A tea and a dinner and visits to the different hospitals of Madras formed the social functions of the Congress.

At the business sessions of the All-India Obstetric and Gynæcological Congress, it was resolved that the Congress should be a biennial one, and at the invitation of the Bombay Obstetric Society, the next session is proposed to be held in Bombay in December 1937. It was also resolved that provincial Obstetric and Gynæcological societies should be formed in Bengal, and if provincial organisations were not possible, two or three Provinces may possibly join together and form a central association, as the Northern India Obstetric and Gynæcological Association, or the Central India Association. The States of Mysore, Hyderabad, Travancore, Cochin and Pudukottah, it was felt, should be included in the Obstetric Association of Southern India.

The question of the publication of a Journal in Obstetrics and Gynæcology was deferred consideration till the formation of provincial societies was complete.

At the next Congress, two subjects were included on which a symposium should be prepared and discussion held, *viz.*,

(1) Toxæmias of pregnancy,
(2) Carcinoma of the cervix uteri.

A resolution was also passed urging that the Indian Medical Council should lay down a standard of training in Midwifery for medical students, which should be not less than 6 months of hospital training and the personal conduct of 20 cases of labour.

M. SRINIVASAN.

Indian Institute of Science—Quinquennial Reviewing Committee.

THE Personnel of the Committee has been announced:—

Chairman:

Sir James Colquhoun Irvine, C.B.E., D.SC., F.R.S.

Members:

Dr. Arthur Henderson Mackenzie, M.A., D.Litt., C.S.I., C.I.E.;

Dr. S. S. Bhatnagar, D.SC., O.B.E.

Secretary:

Mr. F. F. C. Edmunds, M.A., B.SC.

Sir James Irvine who is 58 years old, is the Vice-Chancellor and Principal of the St. Andrews University since 1921. He was formerly Professor of Chemistry and Dean of the Faculty of Science in that University; he served on the Advisory Council of the Department of Scientific and Industrial Research, was lately Vice-President of the Royal Society of Edinburgh and is still Chairman of the Forest Products Research Board.

Dr. Arthur Henderson Mackenzie, born February 1880, is the Pro-Vice-Chancellor of the Osmania University. He was Principal, Government Training College, Allahabad 1908-1919 and Chief Inspector of Vernacular Education, 1919-1921. He was appointed Director of Public Instruction, U.P., 1925-1935. He was also a Member of the Legislative Council, U.P., 1922-34, and the officiating Education Commissioner with the Government of India, 1930-31.

Dr. S. S. Bhatnagar who was recently honoured with the title of O.B.E., is the University Professor of Physical Chemistry and Director of Chemical Laboratories, University of Punjab. He is well known for his researches on Magneto-Chemistry, and is the author of a standard work 'Physical Principles and Applications of Magneto-Chemistry' (Macmillan & Co., London, 1935).

Mr. F. F. C. Edmunds, Inspector of Schools, Coorg and Bangalore, was the Secretary of the last Reviewing Committee constituted in 1930.

Academies and Societies.

Indian Academy of Sciences :

December 1935. SECTION A.—MAX BORN: *The Mysterious Number* 137.—Using electronic units all laws of atomic physics become dimensionless equations with numerical coefficients. These coefficients are not all purely mathematical numbers, but amongst them appears the Sommerfeld fine structure constant $\alpha \left(= \frac{e^2}{\hbar c} \right)$ whose reciprocal is 137. This high value of $\frac{1}{\alpha}$ is the decisive factor for the order of magnitudes of all physical phenomena, when reduced to electronic units. INDER CHOWLA: *Vinogradow's Solution of Waring's Problem. Hypothesis K of Hardy and Littlewood.* B. SANJIVA RAO and K. S. SUBRAMANIAM: *The Occurrence of Furan Derivatives in Volatile Oils. II. α-Clausenan and Di-α-Clausenan.*—The constitution of the clausenans have been further worked up. (LATE) A. N. MELDRUM AND A. S. DATAR: *Reduction of the* —$CHOH.CCl_3$ *Group.*—The reduction products were found to contain the group $CH_2.CHCl_2$. P. V. SUKHATME: *A Contribution to the Problem of Two Samples.* B. F. FERREIRA AND T. S. WHEELER: *A Study of the Benzoin Reaction-V.*—The effect of inhibitors on the benzoin reaction. The inhibiting actions of sulphur, carbon disulphide, thiobenzaldehyde, iodine and quinine on the reaction between pure benzaldehyde and pure solid potassium cyanide have been studied. C. S. VENKATESWARAN: *The Raman Spectra of Some Formates and the Constitution of Formic Acid.*—Both crystals and aqueous solutions have been studied, the lines at 2834 and 2732 giving direct evidence for the existence of CH group in formic acid. P. NILAKANTAN: *Magnetic Anisotropy of Naturally Occurring Substances.—I.—Mother of Pearl.*—The observations indicate that the *c*-axes of the aragonite crystals are in every case normal to the elementary laminæ. K. L. RAMASWAMY: *Refractive Indices and Dispersions of Volatile Compounds of Fluorine and Boron.*—By comparing with the corresponding dielectric polarisations, it is found that the fluorine compounds and the complex compound of Boron $B_3N_3H_6$ have appreciable values of atomic polarisations. B. G. ACHARYA AND T. S. WHEELER: *Detergency of Soap Solutions.*—The adsorption of soap by cotton under standard conditions may be a measure of the detergent action of soap solutions. V. I. VAIDHIANATHAN, GURDAS RAM, AND E. MCKENZIE TAYLOR: *Uplift Pressure on Weirs.*—A Floor with a line of sheet piles.

December 1935. SECTION B.—M. MITRA AND K. F. KHESWALLA: *The Effect of Temperature on the Growth of* Fusarium vasinfectum *Atk.*—The influence of temperature on the growth of *Fusarium vasinfectum* Atkinson causing the wilt diseases of cotton in Western India has been studied. COL. I. FROILANO DE MELLO: *New Trypanosomids of Some Indian Birds.*—Some new trypanosomes of the Indian birds are recorded. M. B. MIRZA AND S. S. NARAYAN: *Strongyloides akbari N. Sp. A New Nematode Parasite from* Crocidura coerulea, *with a Note on Some Species of the Genus Strongyloides.*—A new species of *Strongyloides* from *Crocidura coerulea* has been described. For the first time, *Strongyloides* is recorded as a parasite of reptiles. The occurrence of a new variety of *Strongyloides stercoralis* in fox has also been noted. G. N. RANGASWAMI AYYANGAR, V. PANDURANGA RAO AND A. KUNHIKORAN NAMBIAR: *The Inheritance of Some Characters in Crosses with the Sorghums, Milo and Kafir.*—Data on the inheritances of a few characters from a cross between Blackhull Kafir (*Sorghum caffrarum*, Beauv.) and Dwarf Yellow Milo (*Sorghum caudatum* Stapf.) are presented. A. C. JOSHI AND J. VENKATESWARLU: *Embryological Studies in the Lythraceæ II.* Lagerstræmia *Linn.*—The structure and development of the ovule and embryo-sac in two species of *Lagerstræmia*, namely, *L. indica* Linn. and *L. Flos-Reginæ* Retz. have been described. C. BHASHYAKARLA RAO: *A New Species of* Stichosiphon (Stichosiphon indica *Sp. Nov.*).—The alga found growing as an epiphyte on species of *Cladophora* and *Lyngbya* has been described as a new species of the genus *Stichosiphon* Geitler, and named *Stichosiphon indica* Sp. Nov.

FIRST ANNUAL MEETING.

18th, 19th, 20th and 21st December 1935.—THE FIRST ANNUAL MEETING was held at the Royal Institute of Science, Bombay. His Excellency the Governor of Bombay, inaugurated the meeting. The proceedings of the meeting were broadcast.

Rajasabhabhushana Sir C. V. Raman, KT., F.R.S., N.L., the President of the Academy, in the course of his address, reviewed the progress of the Academy since its foundation. The scientific activities can be considered under three heads: (1) Meetings for discussion of research papers, (2) Symposia on special subjects, and (3) Publication of Proceedings. The President referred to the generous personal gift by His Highness the Maharaja of Mysore, of ten acres of land in the vicinity of the Indian Institute of Science, as a permanent location for the Academy. The location is a historic spot close to one of the four towers set up by Kempe Gowda, a former Hindu ruler, as a limit for the extension of his city. A relief map shows this site to be the highest spot in Bangalore.

A symposium on colloids and sectional meetings were held. Two public lectures, one on "The Human Eye" by Dr. B. K. Narayana Rao, and the other on "Sounds that cannot be heard" by Sir C. V. Raman, were arranged. Several excursions were also included in the 4-day programme of the Session.

The following members constitute the Council for the year 1936 :—

President : Rajasabhabhushana Sir C. V. Raman, KT., F.R.S., N.L.

Vice-Presidents : Dr. E. P. Metcalfe; Dr. Birbal Sahni; Dr. B. K. Singh; Dr. T. S. Wheeler.

Secretaries : Prof. C. R. Narayan Rao; Rao Bahadur Prof. B. Venkatesachar.

Treasurer : Dr. V. Subrahmanyan.

Members of Council : Dr. S. K. Banerji; Major S. L. Bhatia; Dr. S. S. Bhatnagar; Dr. S. Chowla; Dr. R. B. Forster; Prof. K. S. Krishnan; Dr. G. Mathai; Dr. B. K. Narayana Rao; Dr. Nazir Ahmed; Dr. K. R. Ramanathan; Prof. L. Rama Rao; Dr. M. R. Sahni; Dr. M. A. Sampathkumaran; Dr. S. Subba Rao; Sir M. Visvesvaraya.

The Academy of Sciences, U.P.:

December 1935. M. S. DESAI: *The Study of Absorption Spectra of Lead Fluoride.* N. L. PAL: *Hydrogen Ion Concentration and Titratable Acidity at Different Stages of Fruit Ripening.* B. S. SRIKANTAN AND S. RANGACHARI: *Utilisation of Waste Vegetation. I.—Gasification of Prickly Pear* (Opuntia Dillinii). D. S. KOTHARI AND R. C. MAZUMDAR: *The Quantum Statistics and the Internal Constitution of the Planets.* M. N. SAHA AND L. S. MATHUR: *A Critical review of the Current Theories of the Active Nitrogen Phenomenon.*—A new modification of the theory of Saha and Sur, formulated ten years ago, has now been proposed, and the authors have suggested experiments to verify the theory. SATYENDRA RAY: *On Sulaiman's Single Journey Method.*—A criticism of Chapter VII, Section 1 of "Mathematical Theory of a New Relativity" of Sulaiman.

FIFTH ANNUAL MEETING.

December 19, 1935. FIFTH ANNUAL MEETING.—His Excellency Sir Harry Graham Haig, K.C.S.I., the Patron of the Academy, presided.

Prof. N. R. Dhar, President of the Academy, delivered an address on "A new method of nitrogen fixation and conservation, and reclamation of Alkali Lands". In the course of his address, Prof. Dhar pointed out that while the Indian soils, generally speaking, contain sufficient quantities of potash, lime, phosphate and other necessary plant food materials, they are very deficient in nitrogen, containing as they do approximately 0.04 per cent. as against 0.1 per cent. present in the soils of European and other cold countries. By adding molasses to the soil in heaps and ensuring conditions for proper aeration, an increase of over a hundred per cent. in soil nitrogen has been effected. The beneficial effect of crop yields as a result of the application of molasses is seen from the fact that with paddy, an yield of 14.5 maunds per acre as against 8.1 maunds per acre in the control fields has been recorded; an increased yield of 40 per cent. has been obtained with sugarcane. Molasses should be added 2 to 3 months before sowing the crop, the soil, after application, being ploughed 3 or 4 times.

The application of molasses with ammonium sulphate, leads to the conservation of nitrogen, as shown by the fact that the nitrogen content of the molassed soil is always greater than that of the controls where ammonium sulphate alone has been added. A mixture of molasses and ammonium sulphate is thus a better fertilizer than ammonium sulphate alone.

The reclamation of alkali soils can be effected by the application of molasses. The lime which is contained in the molasses, is rendered soluble by the organic acids formed during the decomposition and replaces the sodium of the alkali soils. The tilth of the soil is greatly improved. Alkali lands have been successfully reclaimed in different parts of the U.P. and Mysore by the application of molasses.

His Excellency Sir Harry Haig, K.C.S.I., in the course of his speech, referred to the interesting results of Prof. Dhar's work and said that "it is necessary for the local Government to examine most carefully the economics of their application to practical agriculture".

Members of the Council and Officers of the National Academy of Sciences for the year 1936:—

President: Prof. N. R. Dhar, D.Sc., F.I.S., I.E.S.

Vice-Presidents: Prof. K. N. Bahl, D.Phil. (Oxon.), D.Sc., (Punjab); Prof. A. C. Banerji, M.A. (Cantab.), M.Sc., (Cal.), F.R.A.S. (Eng.), I.E.S.

Hon. Treasurer: Dr. H. R. Mehra, Ph.D.

General Secretaries: Dr. S. M. Sane, B.Sc., Ph.D.; Dr. P. L. Srivastava, M.A., D.Phil. (Oxon.).

Foreign Secretary: Prof. B. Sahni, D.Sc. (Lond.)

Other Members of the Council: Prof. K. C. Mehta, Ph.D. (Cantab.), M.Sc. (Punjab); Prof. M. N. Saha, D.Sc., F.R.S.; Prof. S. S. Bhatnagar, D.Sc; Prof. Ch. Wali Mohammad, M.A., Ph.D. (Gottingen), I.E.S.; Dr. Shri Ranjan, M.Sc., D.Sc. (Toulouse); Lt.-Col. R. N. Chopra, C.I.E., M.B., I.M.S.; Dr. C. W. B. Normand, D.Sc., M.A.; Prof. D. R. Bhattacharya, D.Sc., Ph.D., F.Z.S.; Prof. P. K. Parija, M.A. (Cantab.), B.Sc. (Cal.)

Announcement.

The Education Minister's Gold Medal has been awarded to Dr. Sikhibhushan Dutt, D.Sc. (Lond.), Chemistry Department, Allahabad University, Allahabad, his papers having been judged to be the best published on "Chemistry and Technology" in the *Journal of the Academy.*

The National Institute of Sciences of India:

January 4, 1936.—THE ANNUAL MEETING of the National Institute of Sciences of India was held on Saturday, at the Daly College, Indore, with Sir Lewis Fermor, President of the Institute, in the Chair.

Presidential Address:

THE CORRELATION OF ARCHÆAN ROCKS.

"We geologists do not practise a Science enclosed in a water-tight compartment. We are dependent at every step upon other Scientists. Thus we rely upon help from the Physicists and Chemists in the determination of the Physical Constants and the Chemical Composition of minerals and rocks, in the solution of the problems of Seismology and Geophysics, and in the determinations of the Radio-Active Constants of minerals and rocks; to the Botanist and Zoologist, we look for help in understanding the relationships of the organisms now represented by Fossils; we join with the Astronomer when we pursue our Geology back to the earliest history of our globe and contemplate the relationship of our earth to other Stellar bodies....Geology is, in a way, the Science that synthesises all others, as it is the Science of the Earth upon which we live. The Geologist is therefore often able to provide a check to other Sciences, and to help with suggestions for research."—thus said Dr. Sir Lewis L. Fermor in the concluding part of the Address. In this valuable address, Dr. Fermor gives a brief review of the several methods used in the Correlation of Archæan rocks. After giving a lucid preliminary account of the general problem of stratigraphical correlation, he proceeds to point out that, difficult as is this general problem, the special problem provided by the Archæan rocks is incomparably more difficult—in view of the totally unfossiliferous character of these rocks and the intense metamorphism to which they have been subjected. There are, however, certain criteria available for the correlation of Archæan rocks; but it must be remembered that none of these are constantly available, but that by taking account of this criterion in one

case and that in another, one may expect to succeed in effecting a certain degree of correlation. After enumerating the following available criteria—

(1) Stratigraphical Sequence and Continuity. (2) Structural relationships, *e.g.*, Presence of unconformities and relationship to periods of folding. (3) Relationship to igneous intrusives. (4) Associated ore-deposits of epigenetic origin. (5) Lithological Composition. (6) Chemical Composition. (7) Grade of Metamorphism. (8) Uranium-Lead Ratios and Thorium-Lead Ratios.

Dr. Fermor has touched briefly on each of these as illustrated by definite examples derived from the Archæan terrane of Peninsular India—a field of study in which he can certainly speak with authority. In connection with the first criterion, for instance, it has been pointed out how the recognition of the Sausar series has helped in the complete unravelling of the Archæan Stratigraphy from Sausar to Balaghat in the Central Provinces. The value of the study of associated epigenetic ore-deposits in correlation has been illustrated with reference to the gold deposits of Mysore and Singbhum, and the copper deposits of Singbhum and Sikkim. Talking of Lithological Composition as an aid to Correlation, Dr. Fermor has drawn attention to the Gondite series, a careful study of which leads to the reasonable hypothesis that all gonditic rocks in India may be considered as representing a definite stratigraphical horizon, and as such will eventually enable us to correlate the Archæan rocks of Rajputana, the Central Provinces, and Singbhum. In connection with the "Grade of Metamorphism" as a criterion available for use in correlating the Archæan rocks, Dr. Fermor has discussed, at some length, the views of Van Hise, Grukenmann and Niggli, regarding metamorphism in general—in view of the importance of this subject in the study of our Indian Archæan Schists, and then proceeds to point out, with reference to actual examples, that "We must not be led by the presence of a great general difference between the grade of metamorphism in two tracts of country into assuming that they are necessarily of different age, the more highly metamorphosed tract being on this view, the older. Instead, we must be prepared to consider whether the differences may be due, not to difference of age—by which in this case we mean the more prolonged subjection of the more highly metamorphosed tract to metamorphic agencies—but to the metamorphic forces having been applied with different degrees of intensity to rocks of the same age." Lastly, Dr. Fermor refers to the discovery of radio-activity and says, "In this discovery, we are witnessing the fashioning of a new weapon for determining the age of minerals and thus the minimum age of the rocks containing them—a weapon that in the absence of fossils is particularly welcome to students of Pre-Cambrian Geology."

Considering that this address was to be read before a gathering of eminent Scientists representing all branches of knowledge, Dr. Fermor has rightly refrained from making it too abstruse or technical. Here is true "Geology without jargon", and in delivering such a lucid and informing address on a subject of great importance, we have no doubt that Dr. Fermor has done a great service to the study of Indian Geology.

The following papers were read and discussed:

(1) J. A. Dunn. "A Study of Some Microscopical aspects of Indian Manganese Ores."
(2) Dr. Tashkhir Ahmad, "The Influence of Constant and Alternating temperature on the developmental stages of certain insects."
(3) N. K. Saha, "Studies in the Electron Theory of solid metal."
(4) P. C. Mahalanobis, "On the generalised distance in statistics."
(5) Dr. H. S. Rao, "Pearl-like concretions (Calculi) found in the stomach of a shark (*Zygæna blochii*, Cutrer).
(6) S. L. Hora, "Nature of Substratum as an important factor in the ecology of torrential fauna."

The following members constitute the Council of the Academy for the year 1936:—

President: Sir L. L. Fermor.
Vice-Presidents: Brigadier H. J. Couchman; Professor B. Sahni.
Treasurer: Dr. S. L. Hora.
Foreign Secretary: Prof. M. N. Saha.
Secretaries: Prof. S. P. Agharkar; Dr. A. M. Heron.
Members of Council: Mr. M. Afzal Husain: Dr. Baini Prashad; Mr. T. P. Bhaskara Shastri; Prof. J. C. Ghosh; Dr. F. H. Gravely; Prof. S. S. Bhatnagar; Sir B. C. Burt; Lt.-Col. R. Knowles; Dr. K. S. Krishnan; Prof. S. K. Mitra; Prof. J. N. Mukherjee; Dr. C. W. B. Normand; Prof. N. R. Sen; Prof. B. Venkatesachar; Lt.-Col. S. S. Sokhey; Lt.-Col. J. A. Sinton; Mr. C. G. Trevor; Mr. F. Ware.

Representatives of the Asiatic Society of Bengal:—
Additional Vice-President: Rai Sir U. N. Brahmachari Bahadur.
Additional Member of Council: Mr. C. C. Calder.

Representatives of the U. P. Academy of Sciences:—
Additional Vice-President: Prof. K. N. Bahl.
Additional Member of Council: Prof. A. C. Banerji.

Representatives of the Indian Academy of Sciences:—
Additional Vice-President: Prof. B. K. Singh.
Additional Member of Council: Dr. K. S. Krishnan.

Representatives of the Indian Science Congress Association:—
Additional Vice-President: Dr. J. H. Hutton.
Additional Member of Council: Mr. W. D. West.

Indian Science Congress, 1936:

At the Annual Meeting of the General Committee of the Indian Science Congress Association held at Indore on January 6th, it was unanimously resolved to celebrate the Silver Jubilee of the Indian Science Congress in January 1938 by inviting a deputation of Scientists from the British Association and elsewhere to join in the meeting.

Officers of the Indian Science Congress, 1937.—GENERAL PRESIDENT: Rao Bahadur T. S. Venkataraman. SECTIONAL PRESIDENTS: (1) *Mathematics and Physics*: Prof. S. Datta, Calcutta; (2) *Chemistry*: Prof. J. N. Ray, Lahore; (3) *Geology and Geography*: Mr. W. D. West, Calcutta; (4) *Botany*: Mr. H. G. Champion, Dehra Dun; (5) *Zoology*: Dr. G. S. Thapar, Lucknow; (6) *Anthropology*: Dewan Bahadur Dr. L. K. Ananthakrishna Ayyar, Palghat; (7) *Agriculture*: Rao Bahadur B. V. Nath, Pusa; (8) *Medical and Veterinary Science*: Col. Oliver, Delhi; (9) *Physiology*: Dr. B. L. Bhatia, Bombay; (10) *Psychology*: Dr. K. C. Mukherji, Dacca.

Venue of the Congress—Hyderabad.

Indian Physical Society:

An extraordinary meeting of the Indian Physical Society was held at 4 P.M. on the 13th December 1935, in the Applied Physics Seminar, University College of Science, Calcutta.

Recommendations of the Council for changes in the Rules of the Society were considered and accepted without division. Besides making minor changes, the Council has been enlarged, and will, under the new rules, consist of a President, four Vice-Presidents, the Secretary, the Treasurer and twelve more members, in place of a President, two Vice-Presidents, the General Secretary, the Treasurer and six members.

Following the extraordinary meeting the ninth ordinary meeting of the Society was held at the same place, when the following papers were read:—

(1) "On the Wing accompanying the Rayleigh Line in Liquid Mixtures" by Dr. S. C. Sirkar.

(2) "Studies on Paramagnetism independent of Temperature, Part I" by Dr. D. P. Ray Chaudhuri, D.Sc., and Mr. P. N. Sen Gupta, M.Sc.

(3) "Effect of Magnetic Field on the Viscosity of Liquids, Part II" by Mr. S. D. Chatterjee.

Indian Chemical Society:

November 1935. PRAFULLA KUMAR BOSE AND SUNDAR RAM: *On the colour reaction of certain nitro compounds.* NRIPENDRA NATH CHATTERJEE: *Studies in Diphenyl series. Part IV.—Action of Oxalyl Chloride on Diphenyl Derivatives.* TEJENDRA NATH GHOSH: *Extension of Michæl's Reaction. Part V.* R. N. AGARWALA AND D. C. MANDEVILLE: *The Electrical Conductivity of Potassium Chloride in certain mixed solvents.* JOSEPH W. H. LUGG: *Note on the anomalous redox potentials of sulphhydryl-disulphide systems.* BALWANT SINGH AND RADHA KRISHEN: *Parachor and Chemical Constitution. Part VI.—Quadrivalent Tellurium Compounds.* M. GOSWAMI, H. N. DAS-GUPTA AND K. L. RAY: *Analytical uses of Nessler's Reagent. Detection of Aldehydes. Quantitative Estimation of Glucose. Part I.* DINAKAR KARVE AND KRISHNAJI KHANDO DOLE: *Kinetics of Reactions in Heterogeneous Systems. Part I.—The Reaction between Carbon Disulphide and Alkali.* DINAKAR KARVE AND KRISHNAJI KHANDO DOLE: *Kinetics of Reactions in Heterogeneous Systems. Part II.—The Reaction between Benzoyl Chloride and Water.* SOBHANLAL BANERJEE AND H. K. SEN: *Effect of Ultra-violet Light on Enzymatic Reactions. Part II.—Pepsin.* P. C. MITTER AND SHYAMAKANTA DE: *Condensation of Succinic Anhydride with Phenols and Phenolic Ethers. Synthesis of Derivatives of tetrahydronaphthalene. A Preliminary Note.* DHIRENDRA MOHAN MUKHERJEE: *Methyl-Red as an adsorption indicator.*

A Note.—An Ordinary Meeting of the Society was held on Thursday, 5th December 1935, at the University College of Science, Calcutta. Dr. J. N. Mukherjee presided. The following were admitted as Fellows of the Society: Prof. Jamiat V. Lakhani, M.Sc., Ph.D., D.I., Sind College, Karachi; Sudhansu Sekhar Ghosh, Esq., M.Sc., University Chemical Laboratories, Lahore; and R. C. Srivastava, Esq., B.Sc., Sugar Technologist, Imperial Council of Agricultural Research, Cawnpore.

Dr. P. B. Sarkar delivered a lecture on "The Constitution of the Diazo Compounds from the standpoint of Electronic Theory of Valency."

Indian Botanical Society:

January 1936. P. S. GUPTA: *The Effect of Edaphic Conditions on the Ecological Anatomy of Certain Species.* KALI KINKAR SAMAL: *The Development of the Embryo-Sac and Embryo in* Crotalaria juncea *L.* H. CHAUDHURI: *A Scheme for the Dissemination of the Knowledge of Plant Disease in India and Suggestions for Control of Diseases.* D. P. MULLAN: *On the Anatomy of* Ipomœa aquatica *Forsk., with Special Reference to the Development of Aerenchyma as a Result of injury.* G. C. ALLEN: *Charophyte Notes from Bareilly.* K. R. RAMANATHAN: *On the Cytological Evidence for an Alternation of Generations in* Enteromorpha. P. PARIJA AND P. MALLIK: *The Mechanism of the Bursting of the Fruits of* Impatiens Balsamina *Linn.* P. PARIJA AND P. MALLIK: *The Formation of Cuticle in Relation to External Conditions.* V. S. RAO: *Studies on Capparidaceæ. I.—The Embryo-Sac of* Mærua arenaria *Forsk.* A. C. JOSHI: *Anatomy of the Flowers of* Stellera chamæjasme *Linn.*

Meteorological Office Colloquium, Poona:

At a meeting held on the 17th December 1935, Mr. T. P. Bhaskara Sastry, M.A., F.R.A.S., Director of the Nizamiah Observatory, Hyderabad, gave an account of the work done at Hyderabad in connection with the preparation of the International Astrographic Catalogue. The work includes the determination of the relative positions of stars and their photometric magnitudes; a re-determination of the positions of stars in certain zones is in progress for the detection of stars with measurable proper motions. He also explained the photographic measurements on the positions of the small planet Eros during its last close approach to the Sun in 1934, made at Hyderabad as part of an International programme for an accurate re-determination of the parallax and distance of the Sun.

University and Educational Intelligence.

Annamalai University:

Lectures.

Dr. S. Chowla, Ph.D. (Cantab), Reader in Mathematics, Andhra University, delivered a course of three special lectures on "The Additive Theory of Numbers".

The following members of the Teaching Staff gave talks to the students on the subjects noted against each:

Dr. S. Ramachandra Rao—"Recent Nobel Prize Winners."

Mr. M. K. Muniswami—"The New Deal."

Buildings.

Tenders have been invited for the construction of 12 lecturers' quarters sanctioned by the Syndicate. Designs, plans and estimates for the following buildings are under consideration:

1. Music College.
2. Men's Club.
3. Union Hall.

Agra University:

Annual Report for 1934–35.—The year under report marks a distinct period in the progress of the University and will remain memorable in its annals for the completion of the University buildings, which were declared open by H. E. the Chancellor on 17th November 1934. The University office was removed to the new buildings in January 1935. Arrangements for Inter-collegiate lectures continued during the year and were found to be very useful. Government have discontinued foreign scholarships, which used to be granted to the three universities in the Province by turns in past years. The number of examinees in all the degree examinations has been increasing steadily and this fact alone, among others equally strong, is sufficient to justify the existence of this University. It demonstrates clearly that the University meets a real demand and has been a potent cause of the development of higher education within its jurisdiction. The University is conferring degrees on 1,302 students this year.

The strength of the U. T. C. platoons attached to the University has remained the same as last year. In spite of their repeated requests, the Military authorities have not seen their way to increase the number of platoons and some of their colleges have to go without this useful training. It is hoped, however, that in the near future this long-standing grievance will be removed.

The quality of instruction and standard of teaching imparted in the colleges affiliated to the University have been of a high order, while the standard of examinations has been maintained at its usual high level. All the colleges have done well. By frequent inspections of the affiliated colleges under the guidance of a strong Board of Inspection, the colleges have been required to keep up to the desired standard. The Maharaja's College, Jaipur, has, through the efforts of the University, secured a magnificent building. A new degree college has been started at Bikaner, while they have received application for affiliation of a new college at Alwar.

All the University bodies have been alert and have discharged their duties efficiently. Certain proposals for improving the teaching of Law in the affiliated colleges are under consideration of the Faculty of Law and it is expected that the proposals if adopted will lead to turning out more efficient graduates in Law. Where all have done their part loyally and efficiently, it would be invidious to name some. But the services of the Registrar and the Assistant Registrar deserve special mention, who have worked with zeal and devotion in the discharge of their duties.

Benares Hindu University:

1. *Meeting of the Senate.*—The adjourned meeting of the Senate was held on December 7, 1935. Pandit Madan Mohan Malaviya, Vice-Chancellor, was elected to represent the University on the Court of the Indian Institute of Science, Bangalore. Among matters of academic importance considered by the Senate was the proposal to institute a one-year Diploma Course in Pharmaceuticals. The necessary Regulations were adopted and it was decided to forward them to the Visitor for sanction.

2 *Meeting of the Court.*—The Annual Meeting of the Court was held on December 20, 1935. The following officers were elected:—

Chancellor—Major-General His Highness Maharajadhiraja Raj-Rajeshwar Narendra Shiromany Maharaja Shri Sir Ganga Singh Bahadur, G.C.S.I., G.C.I.E., G.C.V.O., G.B.E., K.C.B., LL.D., A.-D.-C., Maharaja of Bikaner.

Pro-Chancellors.—(1) Major His Highness Raj-Rajeshwar Maharajadhiraja Sir Umed Singh Bahadur, G.C.I.E., K.C.S.I., K.C.V.O., Maharaja of Jodhpur. (2) His Highness Maharaja Sir Aditya Narain Singh, K.C.S.I., Maharaja of Benares.

Vice-Chancellor.—Pandit Madan Mohan Malaviya, B.A., LL.B.

Pro-Vice-Chancellor.—Prof. A. B. Dhruva, M.A., LL.B., I.E.S. (Retired).

Treasurer.—Rai Govind Chand, M.A., M.L.C.

3. *Convocation.*—The next convocation of the University will be held on February 23, 1936. His Highness the Chancellor will preside. Dr. Sir S. Radhakrishnan has been invited to deliver the Convocation Address.

H. H. the Maharaja of Jodhpur, Pro-Chancellor of the University, has consented to perform the opening ceremony of the Institute of Agricultural Research on February 21, 1936.

Dacca University:

Annual Report for 1934–35.—The total number of students on 31st March, 1935, was 960 as against 961 on the corresponding date in the previous session. The Departments of History and Chemistry organised tours of educational interest for their advanced students. The academic societies in connection with the several Departments of study held several meetings in which interesting papers were read and discussed.

The most important change in the staff of the University during the session is the retirement of Prof. G. H. Langley from the Vice-Chancellorship and the appointment of Mr. A. F. Rahman in his place. Mr. N. N. Ghosh, Professor of Law,

retired from service of the University on attaining the age of 55 years, and Mr. J. N. Das Gupta has been appointed Professor in his place. Out of the grant made by the Imperial Council of Agricultural Research to this University, it has been possible to make another appointment and Dr. A. C. Bose has been appointed Research Assistant in Agricultural Chemistry. This is an expanding Department of this University and in this direction the University can make valuable contributions.

Some interesting donations have been received. Shamsunnesa Khanum Saheba, wife of Khan Bahadur Naziruddin Ahmad, Registrar of the University, has donated Rs. 500 for the award of stipends to meritorious resident students of the Salimullah Muslim Hall; the stipends being called "Raoshan Akhtar stipends" in memory of her mother. Messrs. Shyam Chand Basak, Nibaran Chandra Guha Mustafi and Jogendra Nath Sen, executors of the Will of the late Babu Jagamohan Pal, have agreed to place at the disposal of the University a sum of 4 lakhs of Rupees for a Medical College at Dacca in the name of the late Jagamohan Pal. The University will very shortly submit schemes for the consideration of Government. Rai Saheb Devendra Kumar Roy of Dacca has placed at the disposal of the University three securities of Rs. 100 each for the award annually of a silver medal of the value of Rs. 15 to the student who stands highest in the Honours Examination in Sanskrit. The University has gratefully accepted these gifts and the thanks of the University are due to the generous benefactors.

University of Lucknow:

The degree of D.Sc. has been conferred upon Mr. S. K. Pande, Demonstrator in Botany for a thesis entitled "Studies in Indian Liverworts".

The following students have been awarded Research Fellowships in the University:

Physics: Mr. U. K. Bose; *Chemistry:* Mr. A. B. Sen; *Botany:* Mr. K. Jacob, Mr. H. S. Rao, and Dr. S. C. Varma.

The Ruchi Ram Sahni research prize in Botany has been awarded to Mr. H. S. Rao, M.Sc.

The Banerjee Prize has been awarded to Dr. S. K. Pande, Demonstrator in Botany.

Mr. R. S. Mathur, M.Sc., has been appointed a Research Assistant under Dr. K. C. Mehta (Agra) in connection with the scheme for research on Cereal Rusts.

University of Madras:

Two lectures on "THE FERMAT POINT" were delivered by Mr. V. Ramaswami Ayyar, M.A., in October 1935, under the auspices of the University of Madras. The lecturer defined the generalised Fermat point of a set of points $A_1 A_2 \ldots$ for multiples $\lambda_1 \lambda_2 \ldots$, as a point P for which the sum $\Sigma \lambda_i$ PA_i was a minimum. A few elementary theorems shew that the Fermat point of ABC for multiples (0,1,1) is any point of the side BC; for multiples $(0, -1, 1)$ it is any point of BC produced; for multiples $(-a, b, c)$ it is any point of the arc BC of the circumcircle. From these elementary theorems, and a simple principle which he styled the *principle of composition*, the lecturer shewed that the Fermat point for any set of multiples λ, μ, ν can be fixed readily by dividing the possible sets of multiples into a few categories.

The side-lines of a triangle ABC and its circumcircle divide the plane of the triangle into 10 regions. The lecturer shewed that Fermat points for all sets of multiples were confined to 4 of these regions.

In the second lecture, Mr. V. Ramaswamy Ayyar dealt with the analytical solution for the general case and explained the restriction of the position of the Fermat point to certain regions by the failure of Lagrange's conditions for a minimum in the other regions.

University of Mysore:

Central College.—The Diamond Jubilee of the Central College was celebrated on the 6th, 7th and 8th December 1935. There was a Science Exhibition in connection with the celebrations, which was inaugurated by His Highness the Yuvaraja of Mysore.

Oriental Conference.—The Eighth All-India Oriental Conference was held under the auspices of the University, at Mysore on the 29th, 30th and 31st December 1935, and it was opened by His Highness the Yuvaraja of Mysore.

Extension Lectures—The following Extension Lectures were delivered:—

(i) Mr. A. R. Wadia, B.A., Bar-at-Law, on "Contemporary Socialistic Theories" in English at Tumkur.
(ii) Mr. Devudu Narasimha Sastry, M.A., on
  (a) Kalidasana Sandesa:
  (b) Karnataka Samskruti;
  in Kannada at Bangalore.
(iii) Miss B. M. Tweddle on "Development of Rural Industries" in English at Bangalore and Mysore.

Deputations.—At the invitation of the Indian Statistical Institute, Calcutta, Mr. K. B. Madhava, Professor of Mathematical Economics and Statistics, Maharaja's College, Mysore, delivered a course of lectures on the "Theory of Graduation" at Calcutta.

Messrs. B. M. Srikantia, T. S. Venkannaiya and A. R. Krishna Sastry were deputed to attend the Karnataka Sahitya Parishat Conference held at Bombay during the Christmas week.

The following members of the University were deputed to attend the Annual Meeting of the Indian Academy of Sciences held at Bombay during December 1935:—

1. Rao Bahadur Mr. B. Venkatesachar.
2. Mr. C. R. Narayan Rao.
3. Dr. B. Sanjiva Rao.
4. Mr. K. S. K. Iyengar.
5. Mr. L. Rama Rao.
6. Mr. A. Venkata Rao Telang.
7. Mr. L. Sibaiya.
8. Mr. T. S. Subbaraya.
9. Mr. M. P. Venkatarama Iyer.
10. Dr. B. K. Narayana Rao.
11. Dr. A. Nagaraja Rao.
12. Mr. K. S. Gururaja Doss.

Educational Conference, 1935:

The Eleventh Session of the All-India Educational Conference was inaugurated on December 28, 1935, at Nagpur by the Right Hon'ble V. S. Srinivasa Sastry.

Mr. Shyama Prasad Mookerjee, Vice-Chancellor of the Calcutta University, in his Presidential

Address spoke upon the benefits as well as the evils of the present system of higher education. He said that Government should take immediate steps to introduce free and compulsory education throughout India. Technical and industrial education should be based on a minimum of sound general education. "Unrestricted admission to the army and the navy, Government assistance to indigenous industries and a close association between the universities, the industrialists and the educational authorities," are all necessary for a satisfactory settlement of the problem of unemployment.

The following are some of the important resolutions passed at the Conference.—(1) Secondary School Education should be divided into well-defined stages complete in themselves and should have arrangements for diversified courses, which will equip the pupil, along with a cultural education, with the necessary qualification to meet the requirements of modern industry and commerce. (2) The Conference disapproves of the proposals of the Central Board of Education to have separate secondary school and special examinations for recruitment to the various subordinate services. (3) In order to get expert advice for diversified courses in secondary education, the Conference recommends that selected Indians closely connected with Educational work and possessing high educational qualifications be sent abroad for additional training, if necessary. (4) In view of the great urgency and importance of adult education in India and the necessity for co-ordinating the activities of the different Provinces and States in this direction, it is resolved that an All-India Adult Education League be formed under the auspices of the All-India Federation of Educational Associations with headquarters at Calcutta or any other convenient place.

The Conference, further, appealed to the Government for the immediate establishment of an Institute of Education and Psychological Research on an All-India basis. A committee was appointed to investigate the possibility of adopting a common language and script for the country. Another resolution was adopted regarding the celebration of Education Week throughout the country to give the public an idea of the work and the needs of educational institutions. Another important resolution of the Conference favoured the idea that handicrafts should form an integral part of all education—primary and secondary stages.

Post-Graduate Work in the Indian Universities.

THE Inter-University Board has published a pamphlet containing information regarding the Doctorate Theses in Science and Arts accepted by the Indian Universities from January 1930. The brochure is drawn up with the specific object of providing guidance to post-graduate research students, and it contains reference to investigations in Science and Arts pursued in the Universities. Dealing with the three oldest Universities, we find that during the years 1930-35, Calcutta conferred the Doctorate Degree on 48 candidates from whom the University received 120 theses, while Madras during the same period awarded similar degrees to 10 candidates submitting 10 theses, and Bombay offered to one. Some of the comparatively younger Universities like those of Dacca and the Punjab have conferred degrees on 12 and 13 candidates respectively. Nearly 7 Universities in India do not offer doctorate degrees. Candidates from these Universities will have to migrate to other centres if they wish to obtain doctorate degrees, and when they have to do so, the book gives them no information regarding the colleges where facilities for special types of research work exist. The Indian Universities have not adopted a uniform denomination in respect of the doctorate degrees, for example the Ph.D. degree of the Aligarh University is a science degree, while that in the Universities of Calcutta, Dacca, Madras, Lucknow, represents an Arts degree for which Allahabad and Benares have adopted D.Litt. Practically all the theses accepted by the Universities for the doctorate degree are published either in foreign and Indian scientific Journals or in the University magazines, and they will always be available for the 'Scientific World' and for reference by students in the libraries of the Universities which are equipped for post-graduate research work leading to the doctorate degree. However, all research scholars will appreciate the labours of the Inter-University Board in producing this pamphlet which is a sort of made-easy of reference work. We think that diligence in finding out reference to literature on problems under investigation is an index of the students' aptitude for research, and frequently a hunt for special information through heavy volumes results in the discovery of fresh problems and in stimulating new ideas. Does the pamphlet favour this?

In the pamphlet we could discover more than seventy titles of theses without any information as to their destiny. We are not referring to those which are specifically mentioned as not published. "The Scientific World" would wish for more detailed information regarding these important researches than is provided in the pamphlet.

Reviews.

Relativity. By F. W. Lanchester, LL.D., F.R.S. (Constable & Co., Ltd., London. 1935.) Price 12*s*.

This contribution to relativity from a man who learnt it from Minkowski and Runge deserves serious notice. Lanchester is famous for his power of physical insight which is so conspicuous in his fundamental researches in Aerodynamics. An equally characteristic trait of his work is the lack of mathematical developments. As Prandtl* once remarked, this absence of mathematics does not make his writings easy reading but on the contrary "Lanchester's treatment is difficult to follow, since it makes a very great demand on the reader's intuitive perceptions". These characteristics of the author's work are to be abundantly found in the book under review. It is described as "an elementary explanation of the space-time relations as established by Minkowski, and a discussion of gravitational theory based thereon" and is addressed "to the young student who has yet far to go in his mathematical training". The description can be taken to be true as far as Part I of the book is concerned. Here the underlying principles of the special theory of relativity have been made clear by geometrical methods, almost "*visibly*," as the author puts it, by the aid of diagrams. In fact, the treatment is so simple and beautiful that an enthusiastic reviewer of this book has somewhere remarked, if our memory is right, that the arguments could be grasped even by a sixth form student! Such a sixth form student would indeed be a marvel!

Part II, on the other hand, makes a little difficult reading not because of any mathematical formalism, not even because of the complexity of the physical concepts, but on account of the lack of fulness in the treatment of the several topics dealt with and the failure to take arguments to definite conclusions. Perhaps, the value of the work lies in this very weakness. The author has thrown out brilliant and original suggestions for others to pick up and knowing the history of Lanchester's previous work in Aerodynamics, it would be certainly extremely rash to dismiss the author's suggestions as idle speculation without bringing them to a finality by applying mathematical methods. Among the numerous suggestions throughout the book we might choose, as an illustration, the topic of rotation in space-time in Chapter X. The remark that the spin of the electron is to be associated with *a rotation about a time-axis* is highly suggestive and gains extra significance if taken in conjunction with Kramers' recent derivation of electron spin from purely classical relativistic considerations.

A very suggestive and original book on relativity. Finally no reviewer can be said to have done his job properly if he does not pick holes and so here it is: on p. 62, first sentence, it is wrongly stated that $\sqrt{-1}$ is an *irrational* quantity!

B. S. MADHAVA RAO.

*Prandtl, L., "Wilbur Wright Memorial Lecture," 1927, *Journal of the Royal Aeronautical Society*, August 1927, **31,** No. 200.

The Work of the Sanitary Engineer. By Arthur J. Martin, Major, R.A.M.C., T.F. (Retired), M.Inst.C.E., F.R.San.I. Demy 8 vo. (Macdonald and Evans, 1935). Pp. 488. 81 illustrations. Price 16*s*. net.

Any one who has had experience of writing a book on a technical subject, and is therefore aware of the toilsome effort required to marshall and verify references and condense the necessary information, cannot but admire the industry and ability which Mr. Martin has brought to the completion of his task. Mr. Martin's book is moreover no mere compilation from existing publications. It is continually brightened by short illustrations from his own exceptionally varied experience as a Consulting Engineer in many parts of the world, and the criticisms which he permits himself on matters on which opinions may differ are always helpful and based for the most part on first-hand knowledge.

The book is divided into six parts:—I. Sanitary Administration. II. Water Supply. III. Drainage and Sewerage. IV. Sewage Disposal. V. Collection and Disposal of Refuse. VI. Flood Prevention, Land Drainage and Coast Protection.

Part I on Sanitary Administration contains much carefully compiled information of value to the young engineer especially, on such matters as the different bodies concerned with Local Government and Expenditure, Engineering Societies and

Professional Training and the administrative details concerned with Public Works.

Part II on Water Supply contains 12 chapters in which the whole subject is treated comprehensively and in a manner which constantly awakens the interest of the non-specialist reader. It is thus surprising to read that the contents of an ordinary bath may vary from 28 to 70 gallons. The excessive water consumption of American cities where in even middle class houses every bedroom has its own bathroom, may thus be partly accounted for. The increasing use of electrical refrigerators of various types is mentioned as another cause of growing water consumption. The debatable subject of metering is discussed and a useful system is quoted for combating waste by sectional metering of districts during the night.

Parts III and IV on Drainage and Sewerage and on Sewage Disposal respectively are to some extent interconnected. Thus the difficult subject of storm-water demands attention both in the design of sewers and of disposal works. Mr. Martin's views on the methods of dealing with storm-water after reaching the disposal works are practical and sound, inasmuch as he recognises the necessity for dealing thoroughly with the "first flush" of a storm whatever the actual *rate* of flow during the period of the flush may be since all of it is usually highly polluted. He does not, so far as the reviewer has been able to discover, face the difficulty of storm overflows on the sewer itself, prior to the entry of the disposal works. Such storm overflows are a serious source of pollution in many cases and while their necessity may be admitted as a safeguard against gorging of the sewer and possible disaster, it would seem not beyond the ability of the engineer to devise some method of arresting the heavier polluting matters before they are actually discharged into the river or stream there to form mudbanks.

Thoroughly to discuss the fourteen chapters of Part IV on Sewage Disposal would itself require a small book. Suffice it to say here that both the historical development of the subject and the details of recent modes of treatment are handled with fairness and critical judgment. One or two small omissions and errors of statement or printing may be mentioned. On p. 312 it is stated that an Imhoff tank was installed at Whitstable. Actually it is believed the first Imhoff tank in England was installed at the Withington works of the Manchester Corporation and its working was fully reported upon in the Annual Reports of the Rivers Committee. So far as the reviewer remembers no mention has been made in those Reports of the treatment of the effluent from the contact beds at Withington with activated sludge, as stated on p. 349 of Mr. Martin's book. On p. 335 "Stourport" the headquarters of Messrs. Jones & Attwood, the engineering pioneers of the Activated Sludge process, should read "Stourbridge," and in the Bibliography on p. 384 the substitution of "Nitrogen Compounds" for "Nitrogen Conservation" seriously alters the significance of the title of the book referred to.

Such slips however are singularly few in a book of nearly 500 closely printed pages.

The book being written by an experienced sanitary engineer for members of his own profession, it would not be fair to criticise it for its limitations in the domain of biochemistry, especially as its author has always urged the importance of continued scientific research if the treatment of sewage was to be rescued from empiricism. It must be admitted that a greater proportion of the ability of the engineering as compared with the chemical profession has been devoted to the problems of sanitation. The reasons for this are various. The work of the engineer and its importance are more readily recognised by the lay public who have to pay the bill. The engineer of necessity has to supervise construction works of magnitude and so is responsible for control of labour and expenditure. Nevertheless all such expenditure and ability may be largely wasted if the underlying biochemistry is imperfectly understood. Actually the number of scientific fundamental researches, *e.g.*, on the Activated Sludge process, which have appeared since the original papers from the Manchester laboratories, are very few in comparison with the hundreds of papers concerned with mainly engineering features. And yet as the late John Haworth stated, as quoted on p. 347, the Activated Sludge process still offers a boundless field for research and experiment. The work of the Water Pollution Research Board referred to on p. 270, is doing much to remedy this state of affairs, and Mr. Martin is to be congratulated on the fruition

of the appeal he made in a paper read so long ago as 1913 before the Institute of Sanitary Engineers.

His present book should help much towards even more fruitful and intelligent co-operation than in the past between the engineering and chemical professions.

G. J. F.

Electrochemistry, Vol. 1, Principles. By H. J. Creighton. (John Wiley & Sons, Inc. New York; Chapman and Hall Ltd., London 1935. Third Edition. Pp. 502. Price 20*sh*.

Students of Electrochemistry will welcome the third edition of the Principles of Electrochemistry by Creighton. The book is deservedly popular and serves as an excellent introduction to the study of this rapidly growing subject. The exposition of the older classical ideas and methods has been very lucid, and the numerous references to original papers given throughout the book will help the serious student to obtain easily more detailed information on the topics prescribed.

In the second edition in 1927 the author considered carefully "an alteration of treatment throughout the book to conform to the activity concept" but decided that it was advisable to postpone such a change to a future time when more experimental data had been obtained and this and allied conceptions had been stabilised.

In the third edition just published, the author has taken the opportunity of bringing the treatment of many topics into harmony with recent advances. He has succeeded well in his task. We wish, however, that more space had been devoted to recent work on some chapters, *e.g.*, ampholytes, heterogeneous equilibria, electromotive force of oxidation reduction cells. A chapter on photo-voltaic cells would have been also welcome.

There are to be found a few statements in the book, which we hesitate to accept as a correct account of our present knowledge of the subject. To take an example, on page 57, discussing Debye's equation relating dielectric constant with temperature, it is stated that "The results of recent measurements, however, do not entirely verify this equation," and in support, reference is made to the work of Jezewski, *J. Phys. radium*, 1922, **3**, 293.

We heartily recommend this book to all students and teachers of Electrochemistry.

J. C. G.

Electrical Measurements in Principle and Practice. By H. Cobden Turner and E. H. W. Banner. (Chapman & Hall, Ltd., London,) 1935. Pp. 354. Price 15*s*.

This book is chiefly remarkable for the wide range of electrical measurements dealt with, as, in addition to the measurements formerly included in a book of this nature the measurement of electrical quantities at audio and radio frequencies is treated as well as quite a large collection of miscellaneous measurements of considerable general interest. These include temperature, speed, boiler house quantities, X-ray current and voltage, noise and soap quality to mention but a few of them, so that the book becomes a very useful reference and an interesting collection of electrical devices.

After an introductory Part I on units and standards, electrical instruments are classified according to the electrical phenomenon on which their action depends and the authors have then a good deal to say about miscellaneous devices and measurements such as thermionic voltmeters, testing sets, oscillographs and potentiometers A.C. and D.C. This is followed by Part III on the measurement of current voltage, power and energy, chiefly but not entirely, at power frequencies, while Part IV deals with the measurement of resistance, capacitance, etc., by D.C. as well as by A.C. of audio and radio frequencies. Part V deals with indirect measurements and includes many of the interesting devices mentioned above but many more are given under the previous headings also.

From a heavy engineering point of view, however, it might be contended that the book deals only superficially with important aspects such as wattmeter errors and measurement of small differences of phase, while the very important bridge method of measuring power has only a mere mention. Also some additional detail might be expected regarding, *e.g.*, the construction of a valve oscillator to be used as an A.C. source since a very simple form of this appliance can be made and used for bridge measurements. However, in spite of these limitations and considering the scope and price, the book is well worth while.

KENNETH ASTON.

Foundations of Chemistry.—By K. Suryanarayana, Professor of Chemistry, Pachaiyappa's College, Madras. Pp. 703. Price. Rs. 5. (Published by the Author, 326, Pycroft's Road, Madras.)

This is a text-book intended to supply the exact requirements of candidates preparing for the Intermediate Examination of Indian Universities.

Excepting those that deal with purely theoretical topics, all the other chapters contain detailed instructions for laboratory work pertaining to the subject-matter of each chapter. In trying to make the instructions comprehensive, the author has sometimes indulged in superfluous verbiage.

The descriptive portions of the book are quite satisfactory. There is an abundance of diagrams which are very well drawn. A good number of questions is given throughout the book.

The printing and get-up are very good. The book contains most of the material required for the Intermediate syllabus of the Mysore University.

M. SESHAIYENGAR.

Exercises in General Chemistry and Qualitative Analysis. By H. G. Deming and S. B. Arenson. (John Wiley & Sons, Inc. U.S.A.; Chapman and Hall Ltd., London.) Fourth Edition. 1935. Rewritten and Revised. Pp. xv+326. Price 9*s*.

The book under review aims at an elementary laboratory course in General Chemistry for the College Classes as a companion volume to Deming's "General Chemistry". The object of an elementary laboratory course in Chemistry as stated by the authors in their preface is not merely to impart chemical information but to develop the chemical outlook. The student should be made to be familiar with a few representative types of matter and should grasp the general principles of Chemistry; and more than all he should receive a sound training in the experimental technique employed in investigations of a fundamental nature. The first 226 pages of the book are devoted to about 75 practical exercises most of which can be performed by the average student in a 2-hour period. These include the well-known inorganic preparations, verifications of the quantitative laws in Chemistry, fundamental concepts like Oxidation and Reduction, Physico-chemical measurements, such as, verification of Faraday's laws of electrolysis, conductivity of solutions, freezing point measurements, P_H values and heat of neutralisation. A few exercises of Engineering importance, such as, analysis of water and calorific value of fuels are also added. New experiments on Photography and Sensitivity of qualitative tests have been included in the present edition. The latter part of the book deals with systematic qualitative analysis of inorganic mixtures. The special feature of the book is the list of questions at the end of each exercise which will require the student to make careful observations in connection with each experiment as also to understand the theory underlying the same. The book is obviously written with special reference to courses in Practical Chemistry as adopted by American Universities. It would be worth while considering if elementary practical courses in Chemistry in our Universities could not be modelled on lines similar to those adopted in this book.

M. P. V.

The Chemical Control of Conception. By John R. Baker, M.A., D.Phil. (Chapman & Hall, 1935.) Pp. x+173. Price 15*s*.

In reviewing "The Chemical Control of Conception" by Dr. J. R. Baker with a chapter by H. M. Carleton, one is struck with admiration at the scientifically cautious attitude of the author. The book is intended for the expert who amidst the glut of commercially well-advertised contraceptives—both occlusive and spermicidal—has to choose one which would give a cent. per cent. safety and satisfaction. The work has been undertaken at the instance of the English Birth Control Investigation Committee; detailed descriptions are given of the technics which he has standardised for the purpose of accurately grading the spermicidal powers of pure substances and of proprietary preparations. The mode of action of substances upon sperms is discussed and very cautious conclusions are drawn therefrom. Historically it is interesting to note that Kölliker in 1854 made the first investigation of the action of substances upon sperms. As defined by the author "the ideal spermicide for practical use would be a very soluble, stable, non-volatile, inodourous, non-irritant, inexpensive solid substance moderately or strongly spermicidal in the presence of proteins in both alkaline and in acid media within physiological limits". Such an ideal spermicide is

yet to be found. The book contains Appendices of the actions of various chemicals in various dilutions on isolated sperms at various time intervals. The guinea-pig sperm or as it is called "cavy sperm" is the one that has been used throughout. One realises the difficulty on a perusal of the book, in using or in advising to use, any chemical spermicide, whole-heartedly, as hundred per cent. efficient. The chapter on the Pathology of the contraceptives by Dr. Carleton errs, perhaps, on the side of ultra-caution. It is said "in many cases the use of contraceptive substances and proprietary compounds which are permanently adopted by Birth Control Clinics as routine methods, it is not known whether a product is harmful or not by adequate experimental tests"; this is a statement which is absolutely true. Dr. Carleton comes to the conclusion that "a really potent chemical contraceptive which is also devoid of any pathological effects has yet to be found". On the whole, the book is a remarkable and outstanding contribution on the subject of Birth Control. It is well printed; the price is perhaps too high (15*sh.*). I would strongly recommend the book to find a place in the library of every medical man, as also every social worker interested in population problems.

N.

Descriptive Mathematics. By John Maclean, M.A., B.Sc. (Macmillan and Co., Ltd., London, 1935.) Pp. xvi+143. Price Rs. 2–8–0.

This is a companion volume to the author's *Graphs and Statistics* (1926). To quote from the preface, "In contrast with *Graphs and Statistics* (1926) where the stress was laid so much on the applications that mathematicians found but little interest in it, the emphasis here is often intensely mathematical". Apart from a few pages dealing with Finite Differences, the "intense" mathematics is however of the Intermediate standard. The author's intention has not been to produce any text-book to be used by the general class of students. He claims to have introduced new features and methods which would benefit the more enterprising teachers and students. Considering, however, the mathematical knowledge of the students who would use the book, and looking through the contents of the main chapters, it is hard to see how this book would stimulate more think[ing] on the part of an intelligent student th[an] any of the modern well-planned text-boo[ks]. Few teachers would agree that the bo[ok] is successful in presenting "an outlook [on] mathematics which makes it, not [the] embodiment of definiteness and autho[rity] but a home of the free creative spirit".

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Amongst Macmillan & Co.'s mathemat[ical] publications, I have not seen a book u[sing] closer print and worse paper than w[hat] are used here. I should not be surprise[d if] many of the Intermediate students [of] Indian Universities would treat this bo[ok] as one more of their text-books on Eng[lish] Prose—the language used in a book [on] mathematics ought to be far, far simpl[er in] style.

C. N.

Plant Life, A Text-book of Botany. [By] D. B. Swingle. (Chapman & Hall, [Ltd.,] London, 1935.) Pp. 441; Figs. [...] Price $3.

Dr. D. B. Swingle of the Montana S[tate] College, Bozeman, has recently written a [...] text-book of Botany, which has many ex[cel-] lent features. The treatment centres aro[und] the life processes of plants—their meth[ods] of obtaining food, its subsequent use [in] growth and reproduction, and the means [they] adopt to protect themselves from the dan[gers] that beset them. The style of writing [is so] simple that even the dullest student sh[ould] have the minimum of difficulty in work[ing] his way through the first 15 chapters, [deal-] ing with the fundamental aspects of [plant] physiology and structure. Chapters X[V] to XXIV deal with typical representat[ives] of the plant kingdom. The bulk of the ma[t-] ter here is organised in the usual orth[odox] manner, but there is a freshness of treat[ment] that makes it agreeable. A good fea[ture,] not always seen in text-books, is that [in] describing each group of plants the au[thor] gives a paragraph on its economic valu[e and] another on its relationships to other gro[ups]. Chapters XXV and XXVI deal with the [...]

facts of evolution and Mendelism including an account of fossil plants. The last three chapters are devoted to ecological considerations and in the end there is a useful glossary of technical terms. At the close of each chapter there is a list of questions for review, which will serve to stimulate thought on the part of the student and revert his attention to many important facts in the text, which he might have overlooked in the first reading.

The illustrations are in general very satisfactory. Good care has been exercised in the selection of those that have been borrowed from other books. Of these Fig. 163 on *Oedogonium* has evidently been taken from Chamberlain's *Elements of Plant Science*, although the credit line has been omitted due to oversight. Fig. 95 (illustrating secondary growth in dicotyledonous roots), stated to have been borrowed from the *3rd Edition* of the well-known text of Holman and Robbins, is really taken from the older editions. The latter authors have entirely redrawn this group of figures in their latest edition, for it is unthinkable that such an old root as that shown at "D" should have remained without cork formation in the pericycle. In the figures on mitosis a continuous spireme thread has been made in the prophase, although most cytologists are now agreed that the chromosomes remain separate and do not join end to end in this fashion.

On p. 197 it is mentioned that there are at least 200,000 species of seed-bearing plants, while according to the estimates of most taxonomists this number is well under 150,000. In dealing with the life-history of angiosperms, more particularly the development of the female gametophyte, it is mentioned that *Lilium* follows an unusual course and therefore it should be substituted by a general type. Rather ironically the figures accompanying the description are still those of *Lilium* which is clearly a mistake.

On the whole it can be said that the book has many excellent features, which should make it very useful to elementary students of Botany. It is hoped that the defects pointed out above will be remedied in the next edition.

P. MAHESHWARI.

Ciliate Protozoa.

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(5) SUCTORIA. *Ibid.*, II. C 5, pp. 184-226, 228 Figs. (1934). By A. Kahl.

With the publication of the fourth part, just issued, has been completed a monograph on the free-living Ciliate Protozoa of the world, of great worth and practical utility to the workers on the group. Ever since the days of the early microscopists, the ciliates living in ponds and puddles, presenting such a diversity of form and structure, have been favourite objects of study. The number of new genera and species discovered in all parts of the world has gone on increasing, and the serious student of the group is bound to experience considerable difficulty in consulting the vast and scattered literature dealing with them. Saville Kent's Manual of Infusoria, published more than fifty years ago, gave a description of all the forms known till then. Schewiakoff's great monograph on Infusoria aspirotricha (1896) being in Russian, was of restricted usefulness, though the classification introduced by him has been generally followed. Stokes in America (1888), Roux (1901) and Penard (1922) at Geneva have published valuable monographs on the freshwater ciliates, but they only dealt with the forms that came under their personal observation. The works of Blochmann (1895), Eyeferth-Schoenichen (5th edition, 1927), and Lepsi (1926) have all stood the workerin good stead, by making available synoptical keys and short descriptions of a large number of genera and species, but they could not be relied upon for adequate description of all known forms. During the last decade, Dr. Kahl of Hamburg has been unquestionably the most energetic worker on the group, and had published a good deal of important work, before undertaking the monographs now under review. *Die Tierwelt Deutschlands* is supposed to deal with the fauna of Germany and the

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There are books on mathematics written mainly or solely for the use of scientists of other branches, such as chemistry. Similarly, should there be statisticians whose background of mathematics is negligible, they would find the present book a very useful object of perusal, if associated with some text-book such as Freeman's text-book in the Actuarial Mathematics Series.

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(4) CILIATA ENTOCOMMENSALIA ET PARASITICA. *Ibid*., II. C 4, pp. 147-183, 138 Figs. (1934). By A. Kahl.

(5) SUCTORIA. *Ibid*., II. C 5, pp. 184-226, 228 Figs. (1934). By A. Kahl.

With the publication of the fourth part, just issued, has been completed a monograph on the free-living Ciliate Protozoa of the world, of great worth and practical utility to the workers on the group. Ever since the days of the early microscopists, the ciliates living in ponds and puddles, presenting such a diversity of form and structure, have been favourite objects of study. The number of new genera and species discovered in all parts of the world has gone on increasing, and the serious student of the group is bound to experience considerable difficulty in consulting the vast and scattered literature dealing with them. Saville Kent's Manual of Infusoria, published more than fifty years ago, gave a description of all the forms known till then. Schewiakoff's great monograph on Infusoria aspirotricha (1896) being in Russian, was of restricted usefulness, though the classification introduced by him has been generally followed. Stokes in America (1888), Roux (1901) and Penard (1922) at Geneva have published valuable monographs on the freshwater ciliates, but they only dealt with the forms that came under their personal observation. The works of Blochmann (1895), Eyeferth-Schoenichen (5th edition, 1927), and Lepsi (1926) have all stood the worker in good stead, by making available synoptical keys and short descriptions of a large number of genera and species, but they could not be relied upon for adequate description of all known forms. During the last decade, Dr. Kahl of Hamburg has been unquestionably the most energetic worker on the group, and had published a good deal of important work, before undertaking the monographs now under review. *Die Tierwelt Deutschlands* is supposed to deal with the fauna of Germany and the

neighbouring seas, but the free-living ciliates are cosmopolitan in their distribution, and the learned author has wisely given a description of practically all known forms of the world. The scientific periodicals of the world (including some very obscure ones) have been carefully scanned for information, and the genera and species brought under a well-planned system of classification. There are several new families and quite a big number of genera and species which the author himself has established. In all 372 genera and close upon 2,000 species are dealt with. The descriptions are accompanied by more than 2,400 small-sized text-figures grouped together in 155 plates. There are identification tables for families as well as genera and species. The work is very thorough and up-to-date, and the students of the group will bless the author for this admirable monograph.

In the monographs concurrently published in *Die Tierwelt der Nord-und Ostsee* there are synoptical tables of all families and genera, though of course only forms living in sea-water or parasitic in marine animals are enumerated and sketched. In the part dealing with entocommensals and parasitic marine forms, two new sub-orders, Thigmotricha and Apostomea, established by Chatton and Lwoff in 1922 and 1928 respectively, have been included, and the fragmentary information relating to them, hitherto found scattered in a number of papers, brought together.

With this series of monographs the researcher will be guided safely, and no one who aspires to identify known forms or to describe new ones, can afford not to consult them constantly.

B. L. BHATIA.

Electrotechnics, No. 8. (Electrical Engineering Society, Indian Institute of Science, Bangalore.) Pp. xvi+198. April 1935. Price Rs. 2.

The editorial board should be specially congratulated on their splendid success in bringing out this issue of *Electrotechnics*. This number is the biggest of those published so far and contains 29 technical articles, the choice of the subject-matter being so wide that one or the other of them should be of interest to any one in the engineering profession. The topics cover manufacturing processes, electro-chemical industries, design and research notes, electrical communication, electric traction and general engineering.

The editor's scheme for "Nationwide Broadcasting in India" has attracted a great deal of attention. We may disagree with the writer on some such grounds as extravagance but it is obvious that his plan is the result of a careful study of the systems in use in other countries and it must be of great interest to the general scientific reader and in particular to those who will be responsible for the setting up of a broadcasting system in this country.

While this article must necessarily be to a large extent statistical it should be observed that statistics generally make rather dismal reading and there is a tendency in several articles in the number to run to statistics.

Also it might be wished that the publication as a whole could have been less verbose. Engineers should aim at a concise statement of fact rather than at a literary composition.

Considering the scarcity of high class electrical journals published in India and coming, as it does, at the stage of technical development that India is passing through at present, the *Electrotechnics* deserves co-operation from everybody interested in the electrical development of India, both in the industrial and academic fields.

The Calculus of Plenty. By Sir Josiah Stamp, G.C.B., G.B.E., LL.D., D.Sc., F.B.A., being the Norman Lockyer Lecture for 1935, delivered before the British Science Guild on November 13th, 1935.

In this lecture Sir Josiah Stamp seeks to bring into measurable order the various concepts of Plenty comprised under the widespread phrase "Poverty in the midst of Plenty".

He states that all the cases are covered by a main three-fold classification with various sub-heads. First, the plenty of physical or scientific potentiality; second, the plenty of unused or unmarketed production; third, the plenty of unused capacity.

Quoting Lord Kelvin's dictum that "we never know much about anything until we have contrived to measure it," he begs the term "*Calculus of Plenty*" as an indication of the scientific discipline which is necessary for the mind, when it proceeds from its composite concept of plenty, to deductive inferences for human action and policy.

The problem, he contends, is a summation of successive equal units or magnitudes with receding (*a*) *time potentials* (where, for example, an invention can only be brought into full use gradually, (*b*) *cost potentials* (where fuller utilisation of unused capacity involves greater proportionate expense for each unit), and (*c*) *demand potentials* (where increased supplies can only be sold at lower prices).

He then proceeds to analyse the figures submitted by Technocracy and writers in sympathy with the ideas which that movement represents. He points out that the gross theoretical or *technical* capacity based on engineering ideas, has to be brought down to the more important *economic* capacity by a number of stages. These may be shortly indicated as follows: (1) A 100 per cent. use is in practice unattainable, a necessary operating reserve must be maintained. This he terms the *operating margin.* (2) Perfect integration of all industries supplying other industries, and not the final consumers demand, is seldom attained and so results "*unco-ordinated surplus capacity*". (3) Allied to the foregoing, but *not* due to lack of co-ordination is "*seasonal surplus capacity*". (4) Two industries may have surplus capacity technically equal yet vastly different in "practical demand potentiality." People may desire radios more and more and pianos less and less. (5) When demand has strengthened to a point that entrepreneurs are actively providing new plant to meet it, we have *capacity technically displaced on rising demand.* (6) Capacity may also be displaced on a *stationary* demand by reason of new inventions, which may be termed *invention displacement.* We have also to consider (7) *economically misplaced capacity*, (8) *cyclical surpluses*, and (9) *wasteful exploitation, e.g.*, rapid using up of timber without afforestation.

In further interesting paragraphs Sir Josiah discusses actual attempts at measurement and different intensities of demand. In the section on *Gluts, overproduction, restriction and destruction,* he deals with what has awakened the real interest of the general public, such matters as the ploughing-in of cotton and the burning of coffee in Brazil.

Finally he attempts *The Measurement of the Subjective*, *viz.*, "the force of that human desire which alone makes objects wealth".

Altogether the lecture is one which any earnest student of present-day economics may usefully read. Nevertheless and although in fairness to the lecturer it should be stated that while he disclaims any desire to "debunk" the phrase "Poverty in the midst of Plenty", it is difficult not to be reminded of Henry Ford's distrust of "experts". The moment one gets into the "expert state of mind" Henry Ford* says "a great number of things become impossible". The need for exactitude of thought and measurement may be freely granted, but only as a means to an end. Too often the inertia of the human mind is satisfied with such preliminary effort, as a doctor might be satisfied if he can correctly name a disease. The elaborate statistical studies of Seebohm Rowntree and others, though they may have accurately measured the "poverty line" in certain cities, do not seem greatly to have mitigated poverty, the real "trouble of the poor" to quote Bernard Shaw. "The expert state of mind" is too often concerned with things as they are or have been in its experience. Thus it might be conceived that in the days of hansom cabs and "growlers" an expert committee called to report on the possible improvements of street passenger transport in London, would collect all available statistics with reference to the best design of cab, the proper care and feeding of horses, and the necessary education of cabmen. The real remedy is the *taxi*.

In Josiah Stamp's lecture frequent reference is made to prices and profits, and the maintenance of the present financial system would seem to be tacitly assumed. More and more, however, it is coming to be realised by quite responsible thinkers that the present economic system is nothing less than a desperate form of warfare, that the profit motive is incompatible with the more abundant life for the mass of the people. Until that motive is replaced by the spirit of service it may be doubted whether compilation of statistics, however necessary and useful as an aid to reconstruction, will greatly help us to the realisation of true "Plenty" in all its implications.

G. J. F.

**My Life and Work*, p. 86.

Report of the Punjab Irrigation Research Institute for the year ending April 1935. (Printed by the Superintendent, Government Printing Press, Punjab.) 1935.

The Irrigation Research Institute of the Punjab which was established with the object of investigating the rise of the water-table and the consequent serious water-logging brought about by the extension of canal irrigation, has largely expanded its scope of activities and now embraces six major sections dealing with various aspects of the special irrigation problems that the network of canals has brought in its train. The Chemical, Physical, Mathematical, Hydraulic, Statistical, and Land Reclamation sections comprise the Institute at present and fundamental problems as well as those of practical application are being studied, and the Institute is already serving the needs of new irrigation works with valuable data. The most important from the point of view of the agriculture of the tract is certainly the work relating to the deterioration of soils due to alkalinity and the methods of reclaiming them, the initial objects in fact of the Institute. Drainage and washing out of the salts together with applications of gypsum constitute the methods of reclamation of even these highly alkaline soils whose pH values range between 8·5 and 10·0 and which in the first year of reclamation are too stiff for the drains to run. It is interesting to note that in the course of about three seasons the land is improved well enough to grow not only paddy but even sugarcane with moderate yields. The net cost per acre of the reclamation after deducting the income from the crops raised is put down as Rs. 220, and the period of time involved as four seasons.

The Chemical section has also correlated the depth of the underlying kankar layers to the facility of reclamation, the nearer such layer is to the surface the more easy is the reclamation. An easy method of judging the safety of irrigation waters for irrigation is also indicated by noting the ratio of the total Na to the total Ca in the water.

The study of silts has formed an important part of the work in the other sections as likewise the subject of the uplift pressures on dams. The Physical section reports an important method of investigation of such pressures by means of electric appliances which has yielded satisfactory results. The large resort to the use of models in the physical and hydraulic investigations is also a noteworthy feature of the year's work, notwithstanding the difficulty of approximating closely enough to natural conditions which such a method usually presents. A welcome feature of the work in all sections is the association of the Statistical section which is a guarantee of the reliability of the results; this is a fortunate circumstance as most of the field and other experiments of the past in this country have not had this advantage and have suffered in value in consequence. The Institute is probably unique in the comprehensive and many-sided study it has undertaken of problems which concern the welfare of the whole country and both the Director and his colleagues have to be congratulated on the results of the year's work.

Erratum.

Current Science, Vol. IV. No. 6, December 1935. Page 395, hight-hand Column, Line 19 :—

Read $\frac{1}{M}$ *for* M.

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CONTENTS.

Problems of Road Research.

AT the second session of the Indian Road Congress held recently in Bangalore, the delegates, mostly Engineers from the different parts of India, discussed more than thirty papers dealing with the various aspects of their departmental problems. Apart from this professional interest in the construction and maintenance of proper roads, the provision of increasing facilities for vehicular and pedestrian traffic must always be of the utmost importance to the general public. The introduction of motors which has initiated new Engineering problems, must produce even a more profound effect upon the social and economic life of the people than the Railways did before, and the greater range and mobility of these mechanically driven vehicles have brought about a transformation in rural India and in the general methods of transport. The basic facts and the elementary governing considerations of road problems are of such vital character as to necessitate the creation of a Ministry of Transport and a Road Research Board financed by the Road Development Account. The need for a Road Research Organisation is evident from two factors, *viz.*, the large amounts annually expended in India on the construction and upkeep of roads, and the large number of accidents associated with motor transport. The traffic problems are not confined to the technical and professional interests of the engineers alone, but they really belong to the domain of an applied science which includes not only Engineering but also Physiology, Psychology and Pedagogy.

The administration of the Road Development Account is vested in the Governor-General in Council in accordance with the advice of the Standing Committee for Roads. It ought to be the function of the Ministry of Transport to administer the Road Fund from which grants have to be made to the Provincial Governments for the maintenance and improvement of public roads, and the Ministry ought to be the responsible government department for initiating measures to promote the safety of road users. It ought to assume responsibility for the approval of all technical details regarding the lay-out and opening of new roads in all schemes for which grants are made from the Road Development Account. It ought to invite the local governments to submit research programmes with special reference to the traffic

and climatic conditions of the provinces, and their practical applications which must be referred to the Road Research Board for investigation and advice. In such a scheme of co-ordination, the problems to be faced by the Ministry can be grouped broadly under two heads, *viz.*, physical and psychological. The former will include materials used in road-making, the processes of construction, road usage and testing apparatus for judging the durability of roads, and the latter must embrace the utilisation of the knowledge and training of applied psychologists in propaganda and instruction of road behaviour. In certain of its major aspects, the division of work in respect of road direction and control, the medical research worker will also find interesting problems. There is a serious responsibility, therefore, for systematising the information regarding all collateral problems upon which can be based the intelligent control and development of road transport in its engineering aspects.

Under the Constitutional Reforms of 1920, the construction and development of roads became a provincial subject. Though in detail the arrangements made by the provincial governments may vary, the general practice is that in some, the more important roads are under the charge of the provincial Public Works Departments, while in others the bulk of the responsibility devolves upon the District Boards or equivalent local bodies. In most provinces there are three authorities in charge of the roads which are classified under the "large trunk roads" and "feeder" roads. Of recent years, the rural problems have assumed a new character owing to the increase in motor transport, and the construction and maintenance of the most important roads have become an All-India concern which the provincial governments have not the financial resources to deal with adequately. The comparative backwardness of the road transport in India may be an advantage to the railways, as serious competition is eliminated, but it must retard the economic development of the country. The roads under the administration of the local bodies acting as affluents to the main arteries, are indescribably bad, and yet they are the main distributive channels of agricultural produce.

With the advent of bituminous and concrete binders, the dust problem may be considered as having been practically solved, but the main investigation is to enquire into the physical and mechanical properties of the heterogeneous materials, subjected to the changing and the increasing intensity of loads and the influence of weather conditions. Strength and deformability as well as processes of attrition and progressive losses of strength, which occur under different conditions in use, must have a specific relation to the intrinsic properties of the various aggregates and to their distribution on the surface. This aspect of road engineering has a peculiar interest to the research worker, more especially in view of the roads being used by vehicles provided with iron and pneumatic rubber tyres.

Asphaltic bitumens, tar and pitch are all extensively used in road work, and our knowledge of the significant chemical properties of all these binders is still imperfect. During the hot weather when the temperature ranges between 100° F. and 120° F. in most districts, tar melts and rises from the surface in soft outcrops sticking to the heels of the bare-footed pedestrians and of the draught animals. The entire surface becomes corrugated on account of the rolling action of the vehicles, causing serious damage to the motor tyres, and when the tarred roads are hard, the ponies which are extensively used for dragging double-wheeled country coaches, slip and break their bones, besides endangering the safety of the occupants. The black surface of the tarred roads makes visibility poor at night, and must account for the numerous motor accidents on such roads at nights. The bulk of pedestrian traffic is bare-footed in India, and what are the effects on the human system of frequenting tarred roads during the greater part of business transactions. The position at present is that the road engineer is employing material brought frequently under trade names, but of whose chemical composition he has no definite knowledge, and whose effect on the users of the road there is no means of ascertaining.

Generally speaking, the Indian roads are a standing menace to public health, acting, as they do, as the great carriers of infectious diseases. It is the common experience in all the Indian towns that the tarred roads during summer emit intense radiation of heat, parching up the air passages of nose and throat, which is a prelude to the onset of influenza and all other manifestation of bronchial and lung trouble. When the hot winds blow over such roads, carrying the dust particles and other impurities, the eyes and mouth of the users of the road become

involuntarily filled with them. In using any new road binders the road engineers and the public health authorities have to co-operate and conduct experimental work before they are employed on a large scale. Roads have always acted as a source of danger to public health, and all attempts at improving its conditions must be supported by a definite knowledge of experimental investigations in the research laboratories.

The most frequent cause of road accidents arises from the skidding characteristics of the surface. We have at present no knowledge regarding the general influence of vehicle design on skidding, and formal investigation in this direction and in its relation to some conditions of road surfaces becoming slippery is desirable as a means of preventing those conditions from arising. Roads accumulate various types of debris on their surface, and behave differently under seasonal and atmospheric conditions and all these have to be linked with the texture and composition of binders. Another factor which produces road accidents is psychological. The statistical data of accidents have been collected in a more or less mechanical fashion, and few psychological tests have been devised to investigate the human factors in accidents. What is the psychological basis of the various traffic regulations ? Has the effect of these regulations on the driver and on the pedestrian generally been determined ? It must be remembered that the driver of a motor car has to use the eye, the hand and the leg almost simultaneously and does his selection include any examination of how far these organs co-operate in a given situation and how speedily and correctly does his mind form the right judgment? How far does the habitual use of alcohol and narcotics affect the alertness of mind and steadiness of the eye, hand and foot? Equally important with these factors is irritability and impatience, as well as night and colour blindness and defective sight. In such fields of enquiry the psychologists and doctors have to co-operate in the design of traffic and car signals, in the framing of traffic regulations, in the illumination of roads and vehicles and in the selection and rejection of drivers.

Clearly the pedestrian and the cyclist cannot be selected. They are in the habit of picking up their own methods of using the road, and since the traffic regulation is becoming scientific, arbitrary modes of using the road must always produce accidents. It is obvious that they, above all others, should be instructed how to avoid accidents from motor traffic. Instruction in schools and colleges and propaganda by private and aided agencies with a view to impart systematic training may produce the desired results. On the roads it is not uncommon to find the physically deformed and defective people, blind and deaf, old men and unsophisticated children sorely trying the patience of motor drivers, the motor cyclists and bicyclists. We have, on the other hand, villagers carrying head-loads, bullock carts carrying steel girders and bamboo poles, and beggars crossing from foot path to foot path, on sighting a car to stop. The Indian traffic conditions are peculiar, and their control and direction must be based partly on research work and partly upon the education and enforcement of traffic regulations.

The importance of scientifically prepared and accident-free roads in India must become evident when it is remembered that more than fifty per cent. of her population uses the road bare-footed almost from infancy to old age, imbibing into the system the dust and pollution of the road accumulations. Will such an existence improve the physical efficiency of the people ? It seems to us that the multiplicity of problems involved not only in the construction and maintenance of roads, but also in the reactions of such roads on public health, must be the chief argument in favour of instituting a Ministry of Transport and a Road Research Board.

The Golden Jubilee of H. H. The Aga Khan.

ON January 19th and the four succeeding days the members of the Ismailiah section in collaboration with the other communities organised an elaborate programme fittingly to celebrate the Golden Jubilee of the accession to the Gadi of Imamat of their leader Moulana Hazar Imam His Highness Aga Sultan, Sir Mahommed Shah, G.C.I.E., G.C.S.I. We offer our most sincere and respectful felicitations. The preparations in Bombay were especially noteworthy, for the Khoji community wanted to celebrate the occasion in a manner the world would not easily forget. Unfortunately the news of the death of King George spread a gloom over the Country, and in accordance with the personal wish of H. H. the Aga Khan, only the religious ceremonies were observed. The most striking event of the celebrations was the ceremonial of weighing His Highness against bars of gold in a huge balance to assess the tribute from his followers in honour of the occasion. The practice of weighing against gold is associated with rich historical traditions, and it was a common feature of the royal pageantries in the past. Perhaps the faith in the nobility and incorruptibility of the temporal and spiritual ruler is symbolically represented by gold, whose value is distributed among his followers with his benedictions. His Highness, well known for his piety and people zeal, has desired that the entire amount should be devoted to the spiritual advancement of his followers.

When the history of contemporary events comes to be written, the contributions of H. H. the Aga Khan to the political and social developments of the Empire will occupy a prominent place. It will be recalled that he headed the Muslim deputation in 1906 to Lord Minto to urge the case for the increasing association of the members of the community with the administrative and political life of the Country, and, in its formative stages of development, he guided the destinies of the All-India Muslim League, and initiated a fund for raising the Aligarh College to the University status. Gifted alike with the outlook of an astute statesman and the clear judgment of a critical philosopher, he laboured hard to soothe the Muslim sentiments during the Balkan Wars, and the support and loyalty of his immediate followers during the Great War had a most steadying influence on the community as a whole, when Turkey was drawn into struggle. The influence which His Highness has been exercising on the political life of India is largely reinforced by his intimate knowledge of the trend of the public affairs in Europe, and his personal association with the leading allied statesmen. His study of Indian and Middle Eastern affairs in *India in Transition* (1918) produced a great effect on the final form of the Indian Act of 1919, and was consistent with his criticisms of the British Government's Mesopotamian and Arabian policy. He joined in numerous representatives both at the Peace Conference and subsequently in urging on the importance of preserving the sovereign integrity of Turkey to the interests of Europe generally and of Great Britain in particular. For such distinguished services in the promotion of peace, His Highness on whom the titles G.C.I.E. and G.C.S.I., were already conferred, received the honour of a salute of 11 guns and the rank and status of a First Class Chief of the Bombay Presidency. In 1923 the Council of State recommended him for the Nobel Prize.

His war services were great, but those in the cause of the progress of the Muslim Community are greater. As the guardian of the historical traditions of his race and as one of the chief promoters of the Islamic learning and culture, and as a benefactor of Aligarh University, the Aga Khan is entitled to the lasting gratitude of his community. For his great learning and his disinterested efforts in promoting it, the University of Cambridge conferred on him the LL.D. degree. As India's greatest Muslim leader, and as one of her most respected sons, he will always be remembered in the prayers of all the sections of the Indian population.

Recent Work on the Plant Viruses.

By Kenneth M. Smith, D.Sc., Ph.D.,
Potato Virus Research Station, School of Agriculture, University of Cambridge.

DURING the past decade the importance of the plant viruses, both from the purely scientific and the economic points of view, has been realised and increasing attention is being paid to their study. In this article a brief account is given of some of the more recent work which, if it does not explain their nature, at least throws some light on certain aspects of the behaviour of these rather mysterious disease agents.

The field of study covered by present-day investigation of viruses is now so vast that it cannot be adequately surveyed in a single article. In order, however, to give the reader a fairly comprehensive statement of the trend of plant virus research, the subject is dealt with in three sections, and in the first of these one or two important points in the relationship of plant viruses with their insect vectors are discussed. In parenthesis it must be stated that the majority of plant viruses are dependent upon certain insects for their spread from diseased to healthy plants in the field and this relationship between insect and virus is one of considerable interest.

It has for long been assumed that the insect was more than a mere mechanical vector of the virus and evidence that supports this view has gradually been accumulating. The existence of an "incubation period" of the virus in the insect or, as it is better called, a delay in the development of infective power, the restriction of the transmitting power for a particular virus to a single insect species, the retention of the virus within the insect for long periods without recourse to a fresh source of infection, are all evidence in favour of there being some kind of obligate relationship between the insect and the virus. Some recent work by Storey[1] has advanced still further the knowledge of insect relationships with viruses. Working with the streak disease of maize and its insect vector, the leafhopper *Cicadulina mbila* Naude, he has shown that there exist two races of this insect, one of which, the *active* race, is able to transmit the virus, the other or *inactive* race, being unable to do so. These two races are identical in appearance and are undoubtedly both of the same species. Furthermore by crossing the pure races Storey has demonstrated that the ability to transmit the streak virus is inherited as a simple dominant Mendelian factor linked with sex. Now comes a further step, the same worker[2] has shown that a simple puncture of the abdomen with a sterile needle, either following or followed by a feed on a diseased plant, sometimes caused inactive individuals of *C. mbila* to become infective. Storey concludes from these observations that in active individuals of *C. mbila* the streak virus, entering the intestine by the mouth, passes through the intestinal wall into the blood; and that, in the inactive insect, the cells of the intestinal wall resist the passage of the virus. It is recognised that there may be some secondary mechanism of resistance; nevertheless in many inactive individuals, once the barrier of the intestinal wall has been passed, the virus behaves as in an active insect. It is of great interest to find that this type of experiment has been repeated by the animal virus workers using the mosquito *Aëdes ægypti* and an eastern strain of the virus of equine encephalomyelitis which this mosquito does not normally transmit. Three separate experiments were made in which the mosquitoes were allowed to feed on infected guinea pigs and half of them were then punctured in the abdomen with a small sewing needle. When the punctured mosquitoes were allowed to feed on normal guinea pigs, infection resulted, whereas the control mosquitoes that had fed on the guinea pigs at the same time but had not been punctured invariably failed to transmit the disease. Apparently this strain of the virus is incapable of penetrating the intestinal mucosa of the mosquito. If, however, it is inoculated into the body cavity by needle puncture it persists and transmission experiments are positive.[3]

An interesting and important point in the relationship between virus and insect is the question whether a virus can be passed

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[1] Storey, H. H., *Proc. Roy. Soc.*, B, 1932, **112**, 46.

[2] Storey, H. H., *Proc. Roy. Soc.*, B, 1933, **113**, 463.

[3] Merrill, M. H. and TenBroeck, Carl, *J. Exp. Med.*, 1935, **62**, 687-695.

from an infective parent to the progeny. This question has previously been investigated for several viruses and their insect vectors but always with negative results. In 1934, however, Fukushi[4] published the results of his work on the dwarf disease of rice and its insect vector, the leafhopper *Nephotettix apicalis* Motsch. var *cincticeps* Uhl. The results of these studies seem to indicate that this virus *is* transmitted to a certain percentage of the progeny of infective leafhoppers provided that the *female* of the pair is virus-infected. Progeny from crosses between *uninfective* females and infective males were always free from virus.

There is another and slightly different aspect of the insect relationships with plant viruses which must also be touched upon. This aspect concerns the conditions governing the movement and migration of virus-bearing insects in and about the crops. The work in question has been mainly carried out with the chief insect vector of potato virus diseases, the aphis *Myzus persicæ* Sulz., and experiments have shown that humidity has a definite bearing on the movement of this insect and consequently upon the spread of the viruses. Above a temperature of 55° F. which is approximately the minimum temperature in the potato fields in the British Isles during June and July, a relative humidity of 70 per cent. and above will markedly reduce the instances of flight by *M. persicæ*. At higher temperatures of 80° F. and 90° F., the effect of humidity is even more marked and flight is negligible when the humidity exceeds 85 per cent. This work has an important bearing on the selection of districts suitable for growing good " seed " potatoes. Contrary to the usual assumption, high altitudes with bleak exposed conditions are not necessarily the conditions in which aphides are scarce. Indeed the districts in which low infestations of aphides have been consistently recorded are low-lying, often almost at sea-level.[5]

Before leaving the subject of viruses and their insect vectors, it may be of interest to indicate some of the, as yet, unsolved problems connected with natural mode of transfer of certain viruses. Many readers of this journal will be familiar with the important virus disease of sandalwood known as "spike" and the careful and painstaking efforts of Indian workers to ascertain the insect vector of this virus. Now it appears from a note in *Current Science*[6] that the number of possible vectors is being narrowed down; it has been established that the disease is insect-borne and that the vector is probably a nocturnal insect. At the moment interest is chiefly centred on three types of Pentatomidæ, two types of Jassidæ and three of Fulgoridæ. Similarly, much effort has been expended in attempting to identify the insect vector of potato virus X. This virus is exceedingly common and it undoubtedly spreads in the field; experimental evidence has been obtained of its natural spread from diseased potatoes to healthy potatoes, tobacco, tomatoes and various Solanaceous weeds. Transmission experiments with the normal insect fauna of the potato plant, carried on at Cambridge during the last four or five years, have proved negative with the exception of the work with certain species of Thrips. In all, about twelve apparently positive infections with this type of insect have been obtained in four years out of about two hundred tests. If the Thrips is the vector, therefore, and this is not yet proved, then there must be some other factor necessary for successful experimental transmission which is still to be discovered.

In the second section of this article it is proposed to discuss some of the more important advances made in the study of the virus within the plant. It is now recognised that virus diseases of plants are not necessarily due to the action of a single virus but may be caused by the concerted action of a complex of two or more viruses. As a rule the symptoms caused by two viruses are more severe than the disease due to each virus acting singly. A good example of this is the potato disease known as "crinkle" which is caused by two potato viruses of the X and Y types.[7,8]

Occasionally two viruses may produce a symptom picture which, while slightly different from, is no more severe than, the disease produced by either virus alone. In a case like this it would appear as if one virus

[4] Fukushi, T., *J. Faculty Agric. Hokkaido Imp. Univ.*, Sapporo, Japan, 1934, **37**, 2.

[5] Davies, W. M., *Ann. Appl. Biol.*, 1935, **22**, 106-115.

[6] Rangaswami, S., and Sreenivasaya, M., *Curr. Sci.*, 1935, **4**.

[7] Murphy, P. A., and M'Kay, R., *Sci. Proc. R. Dubl. Soc.*, 1932, **20**, 227-247.

[8] Smith, Kenneth M., *Proc. Roy. Soc.*, B, 1931, **109**, 251-267.

cancelled out the other to a slight extent. Again it is possible for a plant to be infected with two viruses but to show symptoms of only one, the second being latent and "carried" without symptoms.

The co-existence of more than one virus in the same plant leads naturally to the question of immunity and this in turn brings up the subject of virus strains. To take the latter subject first, it has been shown that certain viruses of the mosaic group may exist as a number of closely similar strains; this is particularly true of such viruses as those of tobacco mosaic, cucumber mosaic, tomato streak and potato mosaic (virus X). Large numbers of strains of the two first mentioned viruses have been isolated and some of these strains, while having the same general properties, yet may produce entirely different symptoms on similar host plants. This fact of course adds greatly to the difficulties of the identification and classification of plant viruses. Next, as regards immunity, it has been discovered that a plant which is infected with one strain of a mosaic virus is protected from further infection with another strain of the same virus, no matter how different the respective symptom pictures of the two strains may be. On the other hand several strains of the same virus will enter the same host plant if inoculated simultaneously. There is apparently no question of antibody formation in the plant involved; this non-sterile type of immunity depends entirely upon the systemic presence of the virus which entered the plant first. If this first virus is not systemic in the plant, then the second strain may enter those cells which are still free of the first strain.[9,10] It must be understood that this immunity is specific for like viruses and virus strains only; there is no cross-immunity conferred upon a plant against cucumber mosaic, for example, by a previous infection with tobacco mosaic. Here then, the reader will realize, is a useful means of differentiating between different viruses and virus strains and this method is particularly applicable in identifying the virus of cucumber mosaic which affects a large number of ornamental and other plants. A bright "yellow" strain of cucumber mosaic producing unmistakeable symptoms can be inoculated to the plants which are suspected of infection with the ordinary "green" strain of the virus.

The question of the origin of these different strains is an interesting one; do they arise by some mutation process during the inoculations or are they there all the time and are merely being selected out in the serial transfers of the virus? On the whole the evidence is in favour of the theory that new strains arise during inoculation studies[11] and some circumstantial evidence for this view is also available from a consideration of virus complexes as they occur naturally in the field. The following example will perhaps make this point clearer, potato plants are frequently found in the field affected with several strains of the mosaic virus known as X. Now it has been shown that plants infected with one strain of this virus are immune to attack by other strains,[12] therefore it must be assumed in such a case either that the virus X has mutated while in the plant or that these various strains were introduced simultaneously into the plant by one insect vector which seems unlikely.

The recognition that certain viruses produce necrotic spots or local lesions on the inoculated leaf has led to the development of a technique for the more accurate quantitative study of plant viruses. The use of local lesions allows the recognition of large numbers of successful transmissions on single plants and makes possible comparative estimates of virus concentrations. At high concentrations of the virus there is no direct and simple relationship between virus concentration and the number of lesions produced but it is possible within certain limits to tell which of two samples of virus is the more concentrated.[13] In carrying out experiments of this nature it is important to adopt a standard method of inoculation and to compare the virus samples on opposite halves of the same leaves. This is done in order to eliminate as far as possible the effects of variation in susceptibility. The kind and degree of this variation have been examined by statistical analysis and the data submitted to reduction by the analysis of variance. Plants differ greatly in their reaction to inoculation and a gradient of susceptibility was established between the different leaf positions. It was shown that

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9 Kunkel, L. O., *Phytopath.*, 1934, **24**, 437-466.

10 Price, W. C., *Phytopath.*, 1934, **24**, 743-761.

11 Jensen, J. H., *Phytopath.*, 1933, **23**, 964-974.

12 Salaman, R. N., *Nature*, 1933, **131**, 468.

13 Caldwell, J., *Ann. Appl. Biol.*, 1933, **20**, 100-116.

the right and left halves of a leaf responded equally to inoculation procedure.[14,15]

The subject of the cultivation *in vitro* of both plant and animal viruses is one which has claimed the attention of many workers. Upto the present no one has succeeded in growing a plant virus in an artificial cell-free medium and opinion seems to be divided as to whether this has been accomplished with any of the animal viruses. On the other hand several animal viruses have been grown in tissue culture or in media containing fragments of tissue and the virus of influenza is the latest addition to the animal viruses thus successfully cultivated.[16] For a recent review of the situation in regard to the *in vitro* cultivation of filterable viruses the reader is referred to a paper by G. Hardy Eagles.[17]

So far as the plant viruses are concerned, it has recently been shown that the virus of tobacco mosaic can be cultured for indefinite periods in the growing excised tips of tomato roots in a nutritive liquid. There are two rather interesting points which may be mentioned in connection with this method of virus cultivation. First it has not been found possible to inoculate the virus directly into the roots. The tomato plant itself must be inoculated and when the virus has reached the roots, the tips of these can then be cut off and cultured with the virus already within them. The second point is the absence of all symptoms in the virus-containing roots and this may be due to lack of chlorophyll in the roots since the disease symptoms characteristic of virus attack appear to be due to the destructive effect of the virus on the chlorophyll apparatus.[18]

Reference to the existence of viruses in the roots of plants recalls the recent discovery of a rather mysterious virus which is found in the roots of perfectly normal plants belonging to the Solanaceæ and other families. The questions of where this virus comes from and how it gets into the roots of the plants constitute some of the most interesting problems in plant virus research.[19]

The third section of this article is concerned with some aspects of the study of the virus outside the host plant. Improved methods for the ultrafiltration of viruses have been devised by Elford[20] who has developed a technique for the preparation of collodion membranes of uniform and graded pore size. By the passage of viruses through these membranes it is possible to calculate the particle-size of such viruses with considerable accuracy and this technique has now been applied in the measurement of the particle-size of a number of animal and plant viruses. The following are the approximate particle diameters of a few plant viruses as measured by this method; potato virus X, 80-120 $m\mu$, tobacco necrosis virus 20–30 $m\mu$, a new tomato virus 17–25 $m\mu$.*

For a proper study of the virus itself, not only from the point of view of ultrafiltration but also from other aspects, it is important that the virus suspension should be freed from as much of the extraneous matter present in plant sap as possible, and the purification of plant virus suspensions therefore forms a very important part of virus research. Stanley[21] working at the Rockefeller Institute in Princeton states that he has purified the virus of tobacco mosaic until he has produced a crystalline material having all the properties of that virus. Stanley inclines to the view that the virus of tobacco mosaic is an autocatalytic protein rather than a living organism.

The effect of enzymes upon viruses is interesting and important as being likely to throw light on the nature of these agents. First as regards the virus of tobacco mosaic and its reactions with trypsin; although inactivation is produced by this enzyme it is considered for the following reasons to be due partly to a virus inhibitory effect of the enzyme upon the test plant rather than upon the virus itself.[22] The loss of infectivity is immediate without time being necessary for the digestive action of the trypsin upon the virus. Again, the loss of infectivity is produced over a wide range of hydrogen-ion concentrations including some at which trypsin is proteolytically inactive. Lastly, the infectivity of the virus may be regained by heat, by dilution or by digestion and removal of the trypsin.

[14] Samuel, G., and Bald, J. G., *Ann. Appl. Biol.*, 1933, **20**, 70-99.
[15] Youden, W. J. and Beale, Helen Purdy, *Contrib. Boyce Thomp. Instit.*, 1934, **6**, 437-454.
[16] Wilson Smith, *Brit. J. Exp. Path.*, 1935, **16**, 508-512.
[17] Eagles, G. Hardy, *Biol. Rev.*, 1933, **8**, 335-344.
[18] White, P. R., *Phytopath.*, 1934, **24**, 1003-1011.
[19] Smith, Kenneth, M., *Nature*, 1935, **136**, 395-396.

[20] Elford, W. J., *J. Path.* and *Bact.*, 1931, **34**, 505.
* 1 $m\mu$ equals one millionth of a millimetre.
[21] Stanley, W. M., *Science*, 1935, **81**, 644-645.
[22] Stanley, W. M., *Phytopath.*, 1934, **24**, 1055-1085.

Pepsin inactivates the virus of tobacco mosaic at pH 3 at a temperature of 37° C. and the rate of inactivation of the virus varies directly with the concentration of active pepsin. This suggests that the inactivation of the virus is due to the proteolytic action of pepsin and that the virus is therefore either a protein or very closely associated with a protein.[23]

The reactions of potato virus X with enzymes have also been studied.[24] Trypsin appears to have two distinct effects on this virus, one an immediate loss of infectivity and the other a loss of infectivity only after incubation. The fact that the immediate action of trypsin does not affect the flocculation of virus X suspensions with antiserum, whilst on incubation the serological reactions become progressively weaker, is an indication that the effects on mixing and on incubation are qualitatively different.

In the presence of pepsin as in the presence of trypsin, tobacco mosaic virus and potato virus X behave differently. As mentioned above[23], 0·17 per cent. crystalline pepsin slowly inactivates tobacco mosaic virus at pH 3 and 37° C. Virus X, on the other hand, was completely inactivated by a 0·2 per cent. solution of crystalline pepsin in 3 hours at pH 4 and 38° C. Papain alone and cyanide alone had no effect on virus X but the two together inactivated it. This fact is considered to be highly suggestive that virus X contains protein.[24]

Finally, a new and important study, the antigenicity of plant viruses, must be briefly discussed. It has been shown by a number of investigators that antibodies reacting specifically with the sap of certain virus-infected plants can be produced by the intraperitoneal injection of rabbits with such expressed saps. The resulting *antibody*, appearing in the blood serum or body fluids of the hyperimmunized animal, reacts with the *antigen* (plant virus) in some observable way. Three types of reaction have been considered, complement fixation, precipitation and neutralization of the pathogenic properties of the virus. The following facts have now been elucidated by different workers on the serological reactions of plant viruses. The immunization of rabbits with plant virus extracts produces sera which specifically and quantitatively neutralize the viruses concerned.[25] If the virus suspension be filtered through a series of graded collodion membranes the precipitin reaction is only given by that fraction of the filtrate containing the virus. In other words, if the pores of the membrane are too fine to allow passage of the virus, then the filtrate gives no precipitin reaction. The precipitin and complement-fixation reactions are approximately proportional in strength to the quantity of virus present in the sample. These results seem sufficient to show that the antigen causing these serological reactions is the virus itself and not normal constituents of the plant sap.[26]

What then are the practical applications of this technique in the study of plant viruses? First, a delicate test is available for the identification of a virus since the serological reactions are specific for viruses and virus strains. Secondly, the technique can be used as a rapid and accurate means of determining the relative virus content of infective samples and further it is suggested[27] that the antisera afford a method for arriving at a reliable estimate of the total virus in a mixture of strains where the results of virus estimation by counting local lesions on leaves would be misleading. This applies more particularly to a mixture of two or three strains of potato virus X, some of which strains produce no local lesions on inoculated leaves.[28] The attempt has also been made to estimate serologically the absolute concentration of tobacco mosaic virus.[29]

After reading this short article some idea will have been obtained of the activity among present-day virus workers and also of the ramifications of this branch of study into the physical and chemical as well as the biological domains. The collaboration of physicists, chemists, plant pathologists and botanists in approaching this problem is to be welcomed, for only by such team work will the answer finally be obtained to the question—What is a virus?

[23] Stanley, W. M., *Phytopath.*, 1934, **24**, 1269-1289.

[24] Bawden, F. C., and Pirie, N. W. (1936, in the Press).

[25] Chester, K. S., *Phytopath.*, 1934, **24**, 1180-1202.

[26] Chester, K.S., *Phytopath.*, 1935, **25**, 702-714.

[27] Bawden, F. C., *Brit. J. Exp. Path.*, 1935, **16**, 435.

[28] Spooner, E. T. C. and Bawden, F. C., *Brit. J. Exp. Path.*, 1935, **16**, 218.

[29] Chester, K.S., *Science*, N. S., 1935, **82**, 17.

Crystalline Structure and Physico-Chemical Properties in the Colloidal State.

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AS a result of the interesting investigations of P. P. Von Weimarn,[1] Graham's classification of matter into crystalloids and colloids has come into disfavour and it is now admitted on all hands that matter in a particular state of sub-division will in general exhibit colloidal properties. Thus the rôle of sizes in colloidal solutions cannot be over-emphasised as the colour and some of the most important surface properties such as adsorption are to a large extent function of the particle size. One is, however, apt to forget that in such particle sizes as constitute the colloidal state the surface reactivity is also considerably increased and there are rarely, if ever, colloidal particles which are chemically pure. Most hydrophilic colloids are hydrated in water, while the hydrophobic ones get a surface coating of oxides and sub-oxides or form complex solid solutions, while the organosols of metals obtained by arcing even by high frequency and low amperage currents at very low temperatures are seldom free from carbonised matter produced during arcing. The purity of the metal employed is thus in no way a criterion of the chemical purity of the resulting colloidal solution. Even a noble metal like platinum when in a colloidal state has been shown by Pennycuick[2] to be contaminated with PtO_2 and oxy-acids.

These films of impurities considerably mask the properties of the metals themselves and many of the reported changes of colour and other physical properties in colloidal solutions are due to the kinds of impurities occluded with the colloids or the influence of the solvent and oxygen on the fine-grained material. As a classical example of this may be cited the interesting work of Kohlschutter[3] on the silver sols. These sols when prepared in Thuriangian and Jena glass vessels differ in colour; those in Thuriangian glass are yellowish brown to rose red and those in Jena glass reddish violet to dark blue. It was definitely shown that this difference in colour was neither due to the sizes nor to the constituents of the walls of the vessels appreciably entering into the constitution of the micellæ, but was solely due to a different content of Ag_2O determined by the adsorption relationship on the walls. The accurate estimation of Ag and Ag_2O completely established this view.[4] Besides colour, other physical properties such as density, magnetic susceptibility, electrical conductivity and solubility undergo profound changes in the colloidal state for similar reasons and when these impurities are removed chemically or physically the system shows a return to original properties. It is, however, quite conceivable that in the process of colloidalisation or crystallisation the system may undergo more profound changes, for example, a change in the crystal structure or an allotropic modification may take place owing to large pressures and temperatures developed during grinding or arcing or to some other causes such as action of light depending upon the specific properties of the material itself. When this happens, the physical or chemical removal of the film is incapable of completely restoring original properties of the system. This change is then really akin to an allotropic transformation and the new properties acquired are then not a function of the particle size but of the new crystal or molecular structure. This difference is of fundamental importance and has been ignored by many workers while accounting for changes observed in colloidalisation and crystallisation. The changes noticed are due not to particle sizes but to a definite change in crystal structure. One may recall here the famous controversy regarding the yellow and red oxides of lead. The earlier work of Ditte,[5] Geuther[6] and Ruer,[7] etc., showed that the two forms were clearly distinguishable from each other. Glasstone,[8] however, concluded that this difference in colour is due only to the different states of aggregation of the particles. But the later and

[1] *Grundzuge der Dispersoidchemie*, T. Steinkopf, Leipzig, 1911.
[2] *Jour. Amer. Chem. Soc.*, 1930, **52**, 4621.
[3] *Zeit. f. Electrochemie*, 1908, **14**, 49.
[4] Freundlich, *Colloid and Capillary Chemistry*, 1926 Ed., pp. 374-375.
[5] *Compt. Rend.*, 1882, **94**, 1310.
[6] *Ann. der Chemie.*, 1883, **219**, 56.
[7] *Zeit. anorg. Chem.*, 1906, **50**, 265.
[8] *Jour. Chem. Soc.*, 1921, **119**, 1689 and 1914.

more careful work by Applebey and Reid[9] has definitely shown that Glasstone's conclusions are not justified and the two forms are structurally different, the crystalline and optical characteristics of the red oxide being tetragonal, uniaxial and negative and those of the yellow variety rhombic, biaxial and positive. Kohlschutter and Scherrer[10] confirmed the difference in crystal structure by the X-ray method. Their specific diamagnetic susceptibilities are also different, the red variety having a value of $\chi = -0{\cdot}211 \times 10^{-6}$ as against $\chi = -0{\cdot}196 \times 10^{-6}$ for the yellow variety.[11]

Another interesting case is that of the red and the yellow oxides of mercury where R. N. Mathur reports that the magnetic susceptibilities are identical $(-0{\cdot}243-4 \times 10^{-6})$ in both cases which suggests the same crystal structure in both cases. This evidence is beautifully corroborated by Levi,[12] Fricke[13] and Zschariasen[14] who have attributed the colour to particle size as they find that the two oxides are crystallographically identical.

From these observations it is abundantly clear that there are certain physical properties such as colour which may be influenced both by crystal structure as well as particle size. There are other properties such as magnetic susceptibilities which are influenced only by change in the crystal structure or by occluded impurities and do not seem to be much influenced by particle size. The reported changes of magnetic susceptibilities by cold working by Honda and Shimizu[15] in case of copper and tin can be satisfactorily accounted for on the view that in cold working the crystalline structure undergoes modification. This view has found general support by all workers in physics.

[9] *Jour. Chem. Soc.*, 1922, **121**, 2129.

[10] *Helv. Chim. Acta*, 1924, **7**, 337.

[11] *Cf.* R. N. Mathur, Thesis for the D.SC. Degree, Punjab University.

[12] *Gazz. Chim. Ital.*, 1924, **54**, 709.

[13] *Zeit. anorg. Allgem. Chem.*, 1927, **165**, 244.

[14] *Zeit. physikal Chemie*, 1927, **128**, 421.

[15] *Nature*, 1930, **126**, 990; 1935, **135**, 108.

If the forces employed or generated in powdering or colloidalisation are capable of inducing a change in crystal structure, the colloid is likely to show variation in magnetic susceptibilities even after the adsorbed film has been removed, but if the powdering has only changed the particle size and not the crystal structure, the mere sizes will produce no difference in the value of χ when the entrained impurities have been washed away.

It looks to the writer that many old controversies regarding the behaviour of colloids can be reviewed in the light of the above observations. For example, Weigert[16] advocates the view that the stream double refraction in colloidal solutions is dependent upon the size of particles and the distance between them and occurs only when both the particles and the distance between them are amicronic. Against this view is the evidence cited by Freundlich[17] depending on the close relationship between this double refraction and the age of certain sols and the change in ultramicroscopic appearance and structure with age. These changes strongly support the view that the birefringence in such colloids is an intrinsic and not a mere rod double refraction. The X-ray method has also established that changes in crystalline structure on powdering may take place occasionally[18] and the differences in physical and chemical properties obtained in some cases are a function not of the particle size but of crystal structure.

An examination of some of the physical properties of colloidal system such as the peizo-electrical behaviour in gels and the thermal and electrical conductivities of sols and gels will lead to important results particularly in systems where the colloidal state is accompanied by a change in crystal structure. As a matter of fact a complete review of properties of colloidal systems on this view may be well worth-while.

[16] *Cf.* Weigert and Pohle, *Kolloid Zeit.*, 1921, **28**, 153.

[17] Freundlich, *Colloid and Capillary Chemistry*, 1926 Ed., pp. 404 and 411.

[18] Asahara, *Scientific Papers*, *Inst. Phys. and Chem. Research*, *Tokyo*, 1922, **1**, 23.

Magnetic Properties of Colloidal Powders of Metallic Elements.

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1. INTRODUCTION.

IT is the object of this paper to present a critical survey of the experiments which have been conducted to study the dependence of magnetic properties of colloidal particles of metallic elements on their dimensions.

Honda[1] discovered that colloidal suspensions of gold in water prepared by the Bredig method possessed a smaller diamagnetism than the mass metal, but there is very little doubt that the suspension was partly a hydroxide. The problem of the high diamagnetism of bismuth had always been a puzzle and Ehrenfest[2] suggested that if we contemplate the valency electrons to possess large orbits encircling a number of atoms, the anomaly may be explained. This theory was extended by Raman[3] to the case of graphite. In support of these conclusions, Paramasivan[4] showed that the diamagnetic susceptibility of graphite depends on particle size. Vaidyanathan[5] confirmed this result in the case of graphite and obtained similar results with bismuth and antimony. Bhatnagar[6] and his collaborators[7] have maintained the view that such decrease is due to chemical action. Some points of view both from the direction of experiment and from theory are presented to show that the dependence of diamagnetism on particle size is genuine.

The problem of the magnetic properties of metals has been complicated. A few general conclusions have, however, been definitely established. A metal can be considered to be built up of a lattice of metallic ions, the remaining electrons of the atoms being considered free or partly bound in accordance with their energy values. The susceptibility of the metal (non-ferromagnetic of course), is the sum of the susceptibility of the ion and that of the extra-ionic electrons. The first component is constant for a given ion while the latter part is structure sensitive and is dependent on the several physical conditions of the metal under investigation.

A point of great significance now emerges from these considerations. The contribution to the susceptibility made by the extra ionic or the valency electrons depends on the nature of their binding. We may postulate in a general manner three types of binding so far as metallic elements are concerned. In the homopolar type of binding, the susceptibility of the crystal is approximately equal to the sum of the susceptibility of the atoms, as for example, in the case of grey tin. In the metallic type of binding, the electrons are considered to be mobile and shared by the whole crystal. By Pauli's theory,[8] such electrons will contribute a paramagnetic component given by

$$(\chi_A)_e \times 10^6 = 48 \cdot 17 q/V_0[1 - 6 \cdot 113 \times 10^{-9}(T/V_0)^2]$$

where q is the number of free electrons per atom, V_0 is the width of the energy band occupied by the electrons in volts and T the absolute temperature. Superposed over this, there is the Landau[9] diamagnetism equal to one-third of the Pauli paramagnetism. In the third type of binding, we assume with Raman and Ehrenfest that the valency electrons have large orbits, encircling a relatively large number of atoms. A distinction is thus sought to be established between the ordinary homopolar binding in metals and the Ehrenfest-Raman binding. It is now easy to realise that in a metallic crystal some of the valency electrons may possess one type of binding and the others another type of binding. We may cite the case of thallium crystals in which the two valency electrons having their orbits in the hexagonal plane possess a homopolar binding while the third valency electron may be considered as free.[10] In the case of graphite[11] (though not a metal) we have abundant evidence to show that the binding

[1] *Ann. der Phys.*, 1910, **32**, 1027.

[2] *Physica*, 1929, **5**, 388.

[3] *Nature*, 1929, **123**, 945.

[4] *Ind. Jour. Phys.*, 1929, **4**, 139.

[5] *Nature*, 1929, **124**, 762, and 1930, **125**, 820. Also *Ind. Jour. Phys.*, 1930, **5**, 559.

[6] *Ind. Chem. Soc. Jour.*, 1930, **7**, 975.

[7] *Ind. Jour. Phys.*, 1931, **6**, 181; *Ind. Chem. Soc. Jour.*, 1933, **10**, 321; *Curr. Sci.*, 1935, **3**, 611.

[8] Stoner, *Magnetism and Matter*, p. 501.

[9] *Zeits. f. Phys.*, 1930, **64**, 629.

[10] Under publication in the *Phil. Mag.*

[11] *Phil. Trans.*, 1933, **231**, 235.

in the hexagonal plane is of the Ehrenfest-Raman type while in the hexagonal plane it is probably metallic.

2. EHRENFEST-RAMAN BINDING.

It is now easy to follow the effect of colloidalisation on the magnetic susceptibility of elements. The large Ehrenfest-Raman orbits are not possible on the surface of crystals and hence increase of surface area by fine powdering would bring about a decrease in the specific diamagnetic susceptibility. This explanation implies also that the particles are much less densely packed on the surface than in the interior. In support of this conclusion, we have the case of graphite for which it has been shown that the interatomic distance increases at small particle sizes.[12] Thus in those elements like graphite, bismuth and antimony which exhibit large diamagnetism, probably because of large valency orbits, experiments have definitely proved the existence of rapidly decreasing susceptibility at particle sizes less than about $1 \cdot 4 \times 10^{-4}$ cm.[13] That adsorbed layers of gases or chemical actions were not responsible for the observed decrease of susceptibility was conclusively verified in the case of bismuth by showing that the crystal diamagnetism was restored on melting the powder *in vacuo* and cooling.[14]

Graphite colloids were initially studied by Paramasivan, Vaidyanathan and the author. Miwo[15] in Japan studied the susceptibility of different forms of carbon and found that the magnetic susceptibility was proportional to the grain size in the range of amorphous carbon. He thus confirmed the influence of particle size at diameters much smaller than $0 \cdot 15 \times 10^{-4}$, the lowest size reached by the author. Goetz[16] has investigated the magnetic properties of fine graphite particles by producing suspensions of crystalline powders in which these particles were all fixed in a crystallographically parallel position to each other. By this ingenious method, he confirmed the following observations: (*a*) that for particles having diameters above 5×10^{-4} cm., the diamagnetism was independent of particle size, (*b*) that a sudden decrease of the diamagnetic susceptibility occurred at particle sizes below the critical diameter of $1 \cdot 5 \times 10^{-4}$ cm. He has also reported similar results for bismuth and antimony.[17]

The author[18] first drew attention to the possibility of a connection between the critical diameter of $1 \cdot 5 \times 10^{-4}$ cm. for bismuth and the value of $1 \cdot 4 \times 10^{-4}$ cm. obtained by Goetz for the side of the elementary pyramid as observed on freshly-etched surfaces. He also suggested that this coincidence may lend support to the theory of secondary structure proposed by Zwicky. Although this theory has been vigorously criticised,[19] it seems to the author that in a slightly different form as perhaps suggested by Goetz,[20] it may carry greater significance. In fact it is not unlikely that the Raman-Ehrenfest orbits themselves may be responsible for the existence of small blocks in crystals which exhibit high diamagnetism.

Attention may also be drawn to the recent work of Prins[21] who finds for colloidal antimony a diamagnetic susceptibility smaller than for the mass metal. He suggests that in the amorphous state, the metal exists almost like a liquid, *i.e.*, without the Ehrenfest-Raman orbits. This is a striking result which amply confirms our general conclusions.

Lane[22] investigated the diamagnetic susceptibilities of thin films of bismuth and reported no deviation in the range of thickness between $0 \cdot 2\,\mu$ and $15\,\mu$. The author[23] drew attention to the fact that in such experiments the calculated thickness would never give the actual dimensions of the particles and showed that no variation was therefore to be expected. At the same time Goetz[24] reported the same conclusions and mentioned that his experiments with bismuth supported the dependence of diamagnetism on particle size.

Another important direction in which support can be adduced is by introducing foreign atoms into the elements like bismuth

[12] Randall, *Diffraction of X-rays*, 1934, 192.

[13] *Ind. Jour. Phys.*, 1931, **6**, 241.

[14] *Ind. Jour. Phys.*, 1932, **7**, 35.

[15] *Sc. Rep. Tohoku Imp. Univ.*, 1934, **23**, 242.

[16] *Phys. Rev.*, 1932, **39**, 169 and 553; 1932, **40**, 1053; 1934, **45**, 282.

[17] *Phys. Rev.*, 1934, **45**, 293.

[18] Ref. 14.

[19] International Conference on Physics, *The Solid State of Matter*, 1934, pp. 57-139.

[20] Ref. 19, pp. 62-72.

[21] *Nature*, 1935, **136**, 299.

[22] *Nature*, 1932, **130**, 999.

[23] *Nature*, 1933, **132**, 207.

[24] *Nature*, 1933, **132**, 206.

and graphite. Krishnan and Ganguli[25] showed that by the absorption of oxygen atoms between the carbon layers, the abnormal susceptibility along the *c* axis is almost completely destroyed while the value remains the same along the basal plane. Equally interesting are the observations of Goetz and his collaborators.[26] By dissolving small quantities of foreign atoms, it was found that there was a definite critical concentration of the foreign atoms in bismuth, below which the specific effect of the impurity was 10 to 100 times larger than above. This was interpreted as indicating that below the critical concentration, the foreign atoms produced surface effects by getting between the boundaries of groups of atoms within the crystal. These remarkable results lend strong support to the conclusion regarding the dependence of diamagnetism on particle size. It is interesting to draw attention to the observation made by Focke[27] who observed the cleavage plane of a crystal of bismuth infected with polonium while molten and subsequently cooled, with a Geiger counter. He showed that the Po atoms arranged themselves in planes separated by a distance of $0 \cdot 6 \pm 0 \cdot 1\,\mu$ which coincides very well with the spacing obtained for the 111 planes by Goetz[28] by microscopic observations.

Some investigators[29] have mentioned that the observed changes of the susceptibility at small particle sizes may be due to ferromagnetic impurities crystallising out on colloidalisation and thus offering a larger positive susceptibility component, in the manner suggested by Kussman and Seeman.[30] But careful experiments conducted by the writer do not show any evidence of such influence since no changes are observed as the measurements are made at large field strengths.

3. METALLIC BINDING.

We shall now consider the case of metals wherein the binding is of the metallic type. Such metals are good conductors. The valency electrons may here be considered as free, the number of such electrons being of the same order as the number of atoms in the metal. Honda and Shimizu[31] have discussed the problem of cold working and shown that the diamagnetism increases in the case of copper and silver. They have accounted for this result as being due (1) to the Pauli decrease in the paramagnetic component due to the diminution of free electrons caused by the expansion on cold-working[32] (for which evidence is available from X-ray data[33]) and (2) the increase in the diamagnetic component due to the increased number of bound electrons.[34] Honda and Shimizu thus showed that there should be a net increase in the diamagnetic susceptibility on cold-working. A point of great importance is that proper corrections should be applied for the presence of ferromagnetic impurities and any such omission will lead to confusing results as were initially obtained by Honda and Shimizu[35] and also by Bitter[36] and Lowance and Constant.[37] More recently Honda and Shimizu[38] have applied these considerations to the problem of liquefaction and accounted for the observed changes in the case of few metals. They have also drawn attention to the close relation between colloidalisation and cold-working and suggested that on colloidalisation there is decreased density on the surface of the particles and consequently an increased diamagnetic component. These conclusions are abundantly verified in the case of tin and copper by the writer.

The case of tin is of special interest.[39] White tin has a paramagnetic susceptibility of $0 \cdot 036$ (all susceptibility values are given in 10^{-6} units) while in the powder state the susceptibility becomes diamagnetic approaching the value of $0 \cdot 30$ being the value of grey tin. The binding which is metallic in white tin becomes homopolar in grey tin and consequently we have the restoration of the atomic value for tin as the metallic linkages are removed. It is also well known that the conductivity of white tin is much larger than that for grey tin. On melting the powders in vacuum and cooling, the value

[25] *Curr. Sci.*, 1935, **3**, 472.
[26] *Phys. Rev.*, 1934, **45**, 170.
[27] *Phys. Rev.*, 1934, **45**, 219; 1934, **46**, 623.
[28] Ref 20.
[29] Ref. 22.
[30] *Naturwis.*, 1931, **19**, 309.
[31] *Nature*, 1933, **132**, 565.
[32] *Zeits. f. Phys.*, 1927, **41**, 99; 1930, **64**, 629; 1932, **75**, 809.
[33] *Phil. Mag.*, 1934, **18**, 495.
[34] *Zeits. f. Phys.*, 1932, **78**, 283.
[35] *Nature*, 1931, **127**, 556.
[36] *Phys. Rev.*, 1930, **36**, 978.
[37] *Phys. Rev.*, 1931, **38**, 1547.
[38] *Nature*, 1935, **135**, 108; 1935, **136**, 393.
[39] *Proc. Ind. Acad. Sci.*, 1935, **1**, 123.

for white tin was restored. It is interesting in this connection to note that the critical diameter below which the susceptibility changes rapidly is $2 \cdot 0\,\mu$ for tin. Since these results were reported the author has come across a statement of Desch[40] that a dodecahedral face of a tin crystal gives long parallel ridges on etching and that these ridges are crossed by markings approximately $2\,\mu$ apart.

Similarly on colloidalisation by condensed electrical discharge in an inert liquid in the absence of air, copper showed an increased diamagnetic susceptibility.[41] The behaviour is quite similar to what is observed when this metal is subjected to cold-working. The critical diameter below which large changes were observed was $0 \cdot 8\,\mu$ being much smaller than the corresponding values for bismuth, graphite and tin. Honda and Shimizu's theory will suggest that the density of the metal on the surface layer of the particles should be much less than in the interior. An approximate calculation indicates that the thickness of this surface layer is probably 300 A.U. and its diamagnetic susceptibility $0 \cdot 200$. This will mean that the density of the surface layer is $8 \cdot 404$ as against $8 \cdot 943$ for the mass metal. It is likely that the observation of G. P. Thompson[42] that electrolytically deposited copper on the etched surface of a copper crystal has a higher spacing than ordinary copper as determined by electron diffraction methods is borne out by fact.

Vaidyanathan[43] worked with gold and silver particles prepared by the method of Zsigmondy but his deduction is uncertain since he compares his colloidal values with those given for the mass metals in the *International Critical Tables*, particularly when it is remembered that different investigators have given different values even for the same metal.

4. HOMOPOLAR BINDING.

In the light of the foregoing discussion it is apparent that in the case of metals wherein the binding is predominantly homopolar, colloidalisation will not result in any appreciable change in susceptibility. The results that have been observed with selenium are difficult to understand.[44]

5. FERROMAGNETIC METALS.

The ferromagnetic metals stand on a different basis altogether. Heisenberg's[45] theory presupposes the existence of micro-crystals within the crystal, the resultant spins of these micro-crystal having random orientations which compensate each other in the absence of an external field. Bitter's[46] model for a ferromagnetic body based on the block structure theory of Zwicky, consists of micro-crystals each of these containing about 10^5 atoms. On colloidalisation, a large number of such micro-crystals may suffer disruption on the surface of the particle and these broken ones may not give rise to any ferromagnetic intensity since the blocks are not complete for an internal field.

Montgomery[47] showed that fine particles of nickel produced by an electrical dispersion method in an inert liquid in the absence of air had a smaller intensity of magnetisation than the mass metal. These experiments were repeated in a slightly different manner by the author and his results were confirmed. Support for this point of view may also be had from the investigations on thin films of nickel. Langmuir,[48] Steinberg,[49] Sorensen,[50] Wait,[51] Howey[52] and others showed that the films prepared by depositing nickel vapour on a cool surface really consisted of minute crystal grains, too small to be distinguished in a microscope. Ingersoll and De Vinney[53] obtained almost non-magnetic films of nickel by depositing the metal on a cold surface. On heating the film the usual magnetic value was obtained probably because of recrystallisation. More experiments with ferromagnetic metals are necessary to establish these conclusions with certainty.

ABSTRACT.

A critical account is presented of the investigations on the magnetic properties of colloidal powders of metals. Three types of binding of the valency electrons in metals are contemplated: (1) metallic,

[40] Ref. 19, p. 109.

[41] *Proc. Ind. Acad. Sci.*, 1935, **2**, 249.

[42] *Proc. Roy. Soc.*, 1931, **133**, 1.

[43] *Nature*, 1931, **128**, 302.

[44] *Nature*, 1934, **134**, 497.

[45] *Zeits. f. Phys.*, 1928, **49**, 619.

[46] *Phys. Rev.*, 1931, **37**, 90.

[47] *Phys. Rev.*, 1932, **39**, 163.

[48] *J. Am. Chem. Soc.*, 1916, **38**, 2221.

[49] *Phys. Rev.*, 1923, **21**, 22.

[50] *Phys. Rev.*, 1924, **24**, 658.

[51] *Phys. Rev.*, 1922, **19**, 615.

[52] *Phys. Rev.*, 1929, **34**, 1440.

[53] *Phys. Rev.*, 1925, **26**, 86; see also *Phys. Rev.*, 1929, **34**, 972.

(2) homopolar and (3) Ehrenfest-Raman. The influence of colloidalisation on the magnetic properties of metals in which these types of binding are present is mentioned. Attention is drawn to the experiments by Goetz on the effect of small quantities of foreign metals in bismuth crystals. The close analogy between colloidalisation and cold-working in the case of metals wherein the metallic type of binding is predominant, is considered in the light of Honda and Shimizu's theory. Brief mention is made of the investigations on nickel powders and films in the light of Heisenberg's theory.

The Chemistry of Antimalarials.

By Tejendra Nath Ghosh,

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THE toll of malaria in India and other parts of the world is increasing day by day. Malaria is described as a great, if not the greatest, obstacle to the physical, intellectual and economic progress of the people, the enormous mortality and labour inefficiency caused by this disease being a matter of dismay. The seriousness of the epidemic that raged last year in Ceylon may be realised from the fact that 74,000 deaths were caused by this disease during six months. The situation afforded an opportunity to test on a mass scale the value of quinine and of synthetic antimalarial drugs and the report thereon should prove of great value. In view of the fact that malaria causes an enormous waste of human efficiency, any well-planned chemical investigation undertaken as a campaign against malaria will indeed prove a beneficent factor in the amelioration of human distress and in the promotion of international welfare.

For the last half-century, quinine has been considered pre-eminently effective in the treatment of malaria and the selective cultivation of cinchona, in India and Java, has aimed at a maximum yield of quinine. Cinchona bark contains some twenty alkaloids. It is becoming increasingly clear, however, that several other alkaloids are at least as potent as quinine and instead of the expensive pure quinine, the crude mixed cinchona alkaloids are now being used. A comparative examination[1] of specially purified specimens of the principal cinchona alkaloids and their dihydro bases, has revealed that dihydroquinine is more active and that dihydroquinidine, cinchonidine and quinidine are less active than quinine. Our knowledge as to what particular group of the quinine molecule is responsible for its pronounced physiological activity is far from complete, for other alkaloids are known which show a similar physiological activity without possessing the various features of its constitution. Quinine has not been synthesised in the laboratory and, even if it had been, its industrial synthesis would, in any case, be too expensive. In view of the fact that the alkaloids of cinchona bark are not effective for certain therapeutic purposes, particularly for true causal prophylaxis, the prevention of relapses and the prevention of spread, the problem of finding a cheap and efficient quinine substitute is one of great importance.

In 1891 Grimaux and Arnaud prepared from cupreine, a series of homologues of quinine, one of which, ethyl cupreine, was tested clinically and found to be somewhat more active than quinine. Tappeiner, as long ago as 1895, found that certain quinoline derivatives, notably 2-phenylquinoline, kill paramæcia *in vitro* in greater dilutions than quinine itself, but they failed to have any curative action on malaria. Before the structure of quinine had been elucidated by Hesse, Königs, and Rabe, attempts at the synthesis of compounds which might be similar in constitution to quinine led Knorr to the synthesis of antipyrine and Skraup in 1883 to that of the hydroquinoline derivative, thalline. Neither of these has any antimalarial action, though both are stronger antipyretics than quinine. In the year 1913, Kaufmann[2] synthesised β-piperidino-α-hydroxy-(6-ethoxyquinolyl-4)-ethane which was toxic to paramæcia and had a marked antipyretic action in human fevers. Schulemann and his co-workers in the laboratories of I. G. synthesised a series of quinoline and acridine derivatives with

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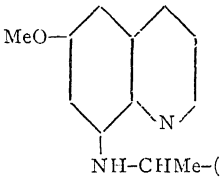
[1] Buttle, Henry and Trevan, *Biochem. J.*, 1934, **28**, 426.

[2] *Ber.*, 1913, **46**, 1823.

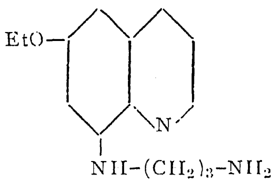
a basic side-chain and these were tested by Roehl and Kikuth on canaries. The Bayer Company, in 1926, announced the preparation of a relatively simple compound, plasmoquine, which was stated to possess a specific action on the malarial parasite; this synthesis has proved to be the first step into a new field of chemotherapy.

Since the discovery of plasmoquine to which structure (I) has been assigned by the I. G. Farbenind. A.-G., several workers have synthesised compounds similar to plasmoquine in structure.



(I)

The derivatives of 8-aminoquinoline have special interest in connection with the subject of antimalarials; thus Baldwin[3] condensed 8-amino-6-ethoxyquinoline with γ-bromopropylphthalimide and obtained a product which, on hydrolysis, yielded the compound (II) similar in structure to plasmoquine.



(II)

The method developed by Baldwin has been extended by several workers,[4] and several products possessing powerful antimalarial properties[5] (against bird malaria) have been obtained. A few of them resemble plasmoquine and are nearly equal to it in potency. Fourneau and his collaborators[6] tested a series of such compounds on rice finch and found 8-diethylamino-propylamino-6-methoxy-quinoline to be equal, if not superior to plasmoquine and this has now been placed on the market under the name of plasmocid. Brahmachari and his co-workers[7] prepared some alkylaminoquinoline derivatives amongst which special mention may be made of 6-methoxy-8-amino*iso*propylaminoquinoline, structurally related to plasmoquine.

Whilst extending the above line of research for the preparation of new antimalarials, one should bear in mind that even small variations in the substituents (though of no interest from a purely chemical point of view) produce effects of marked biological significance. For instance, the 6-methoxyquinolines are more potent than the similarly substituted 6-ethoxyquinolines, and the length of the alkylaminoalkyl chain in position 8 of 8-amino-6-ethoxyquinoline has a considerable bearing on the activity. Magidson and Strukov[8] claim that the 6-hydroxy-derivatives are in some cases more active than the corresponding alkoxy-derivatives, the efficiency decreasing with the size of the alkoxy-group. In evaluating a drug, its therapeutic efficiency and toxicity are both taken into consideration, and in the study of antimalarials of the type of plasmoquine the aim should be to obtain products possessing lower toxicity combined with an equal or increased therapeutic efficiency.

Gunn and Marshall[9] reported that harmaline, although inferior to quinine, possesses curative value in acute malaria, whilst harmine, though valueless in acute cases, prevents recurrence of attacks in cases of relapsing malaria in which administration of quinine is without value. Robinson[10] has synthesised pyrroloquinolines having similarity in structure to harmine and harmaline. Pyrryl indoles, synthesised by Rây and his co-workers,[11] are likely to possess antimalarial properties, in view of their similarity to harmine. Preliminary trials have indicated that they have antipyretic properties. Glyoxalinquinolines, synthesised by Narang and Rây,[12] have been found to possess antimalarial properties and appear to be actively toxic to paramæcia in a dilution of 1 : 1000. Rây and his collaborators[13] have synthesised some derivatives

[3] *J. Chem. Soc.*, 1929, 2959.

[4] Kermack and Smith, *J. Chem. Soc.*, 1931, 3096; Baldwin and Robinson, *ibid.*, 1934, 1264; Meisel and Robinson, *ibid.*, 1934, 1267.

[5] Tate and Vincent, *Parasitology*, 1933, **25**, 411.

[6] Fourneau, Trefouel, Bovet and Benoit, *Ann. inst. Pasteur*, 1931, **46**, 514.

[7] Brahmachari and Das Gupta, *J. Indian Chem. Soc.*, 1932, **9**, 37, 207.

[8] *Arch. Pharm.*, 1933, **271**, 359.

[9] *Proc. Roy. Soc. Edin.* 1920, **15**, 145.

[10] *J. Chem. Soc.*, 1929, 2948.

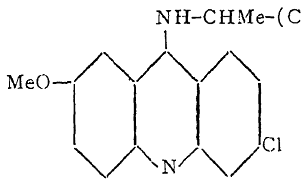
[11] Aggarwal, Qureshi and Rây, *J. Amer. Chem. Soc.*, 1932, **54**, 3988.

[12] *J. Chem. Soc.*, 1931, 976.

[13] Ahluwalia, Kochhar and Rây, *J. Indian Chem. Soc.*, 1932, **9**, 215.

of cotarnine. These have been found to have antipyretic properties but Chopra and his co-workers[14] have found, however, that anhydrocotarnineresorcinol hydrochloride has no antimalarial action.

Atebrin (III), a synthetic antimalarial which is as remarkable as plasmoquine, was discovered by Mauss and Mietzsch in 1930. These investigators[15] found atebrin to be very effective against the schizont modification of the malarial parasite and consider that it should be very successful in conjunction with plasmoquine, which is effective against the gamete modification.



(III)

According to the discoverers of atebrin, the most varied acridine derivatives of the above type and other ring systems containing similar basic aliphatic side-chains (*e.g.*, triphenylmethane, thiazine, xanthine; see *Klin. Woch.*, 1933, **12**, 1276) are active antimalarials. Walls[16] has recently synthesised a phenanthridine derivative containing the same basic side-chain as atebrin. The pharmacological examination shows that phenanthridine is notably less active than its otherwise closely analogous isomeride acridine and differs from the latter in its lack of dermatitic and sternutative action.

The recent use of salvarsan and stovarsol in benign tertian malaria, as well as that of mercurochrome (dibromohydroxy-mercurifluorescein) suggests that the study of organo-metallic compounds would constitute an useful line of enquiry.

The difficulty of forming an accurate estimate of the value of any particular antimalarial agent arises from the fact that the actual infection cannot be transmitted to laboratory animals. This difficulty was partially removed when Roehl devised his technique of testing such drugs in bird malaria, using canaries as test animals, but ultimately one is dependent on clinical trials for confirmation.

[14] Chopra, Mukherjee and Campbell, *Indian J. Med. Research*, 1933, **21**, 255.

[15] Mietzsch and Mauss, *Angew. Chem.*, 1934, **47**, 633.

[16] *J. Chem. Soc.*, 1935, 1405.

The Detection of Adulteration of Butterfat (Ghee).

(A Suggested Solution of an All-India Problem.)

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THE adulteration of butterfat (ghee) has been penalised by all the Provincial Governments of India and some of these have already taken very serious steps to punish the dealers in this important article of food, whenever the adulteration has been detected and proved in a law-court. Every province has got a special Chemical Analyser, whose business it is to examine and report on the samples of ghee (as also other food-stuffs) submitted to him for report. The act dealing with the prevention of food adulteration empowers the trying magistrates to decide the cases before them on the strength of the reports submitted by the special officers. In the interests of the vast public, it is but necessary to punish those who sell adulterated ghee (as also other adulterated food-stuffs). The responsibility which rests on the Chemical Analysers to the various Governments is therefore very great indeed. In the interests of justice and also in the interests of the public for whom justice is administered, it is of paramount importance that the investigation of the adulteration must be both scientific and correct.

In our investigation of this problem, we have come across certain points which need a very careful consideration. The main problem is, what are the correct physical and chemical constants of butter and butterfat from the scientific point of view? What are the limits of these? How is the purity or impurity of both butter and butterfat to be ascertained? Is there, in the first place, a correct knowledge of the composition of Indian butter or butterfat, from cows and buffaloes, either separately or mixed? Are the differ-

ent Provincial Analysts in India agreed on a unanimous standard of the limits of constants of pure butter and butterfat? Has sufficient work been done on the subject in India and have the chemists concerned met and discussed their experimental data obtained from Indian samples? All these questions must be answered and decided before any sample is pronounced as adulterated.

The results obtained in this Laboratory have already been published in the form of a booklet entitled *Butterfat* (by N. N. Godbole and Sadgopal) wherein certain new methods have been suggested. It is, of course, necessary that the methods proposed by us should be carefully examined by the Provincial Chemists before they are made generally applicable. It is, therefore, important to examine the various standards adopted by the Government Chemists in the different provinces of India. We are thankful to the various Chemists who supplied to us the information which has been put together in the following Table:

A brief summary of Standards adopted in various provinces of India for the purity of "Butterfat".

No.	Name of the Laboratory	Standards for mixed Butterfat		Remarks
		Refractive Index at 40° C. Butyro-reading	Reichert-Meissl Value	
1	Bengal, Government of	Not less than 40 and not more than 42·5	Not less than 28	Determination of Saponification value if necessary
2	Bihar and Orissa, Govt. of	40 to 42	Not less than 28	Phytosterol acetate test to be negative in all cases
3	Bombay Corporation	40 to 44·5	Not less than 24	
4	Calcutta Corporation	Not less than 40 and not more than 42·5	Not less than 28	Saponification value to be determined if necessary
5	Karachi Municipality	Not less than 40·5 and not more than 44·2	Not less than 24	Polenske value, Kirschner value and qualitative tests for hydrogenated oils are made when necessary
6	Lahore Municipality	Not less than 40 and not more than 41·6	24 to 32	Not more than 2·6 per cent. of free fatty acid allowed
7 & 8	Madras, Corporation of Madras, Government of	A general examination of the sample is made	Not less than 22, also should be above 27	Not more than 1 per cent moisture: Sterol acetate, Iso-oleic acid, etc. Isolation of Sterol-acetate, estimation of Iso-oleic acid and other tests for a thorough examination
9	Mysore, Government of	——	——	No Standards are fixed as yet
10	Nagpur Municipality	From 40 to 46	From 19 to 36	——
11	New Delhi Municipality	——	——	No Standards are fixed as yet
12	Punjab, Government of	40 to 42	24 to 32	Baryta Value (Lallement's process to be negative. Free fatty acids to be not more than 2·8 per cent.)
13	Pusa, Agricultural Institute	Abbe's Scale 1·4524 to 1·4538	26 to 42	Saponification value and Iodine value (Hube) are also determined if necessary
14	United Provinces— (*a*) Agra (*b*) Lucknow	Not less than 40 and not more than 51 at 25°C.	Not less than 28	Moisture to be not more than 1 per cent. and Saponification value to be determined if necessary

From the above Table, it is clear that the different provinces in India are not only not unanimous in their criteria of the purity of butterfat, but they differ widely even in the limits of the values they have laid down. A student of science or a specialist in oils and fats will find the differences in the standards of different provinces too wide to be justified. Indeed, looking to the values tabulated above, it is clear that a sample which will be pronounced as pure by one Provincial Analyst will be dismissed as positively adulterated by another Provincial Chemist. It is high-time, therefore, that a conference of all the chemists interested in the investigation of butter and butterfat be called as early as possible to discuss :

(1) the limits of the physical and chemical constants of pure butterfat, and
(2) to standardise the methods for the detection of the adulteration, both qualitative and quantitative.

Coming to the scientific aspect of the standards, just at present. the Reichert-Meissl Value and the Refractive Index (with the help of the Butyro-Refractometer) are the two main tests by which the purity of butterfat is ascertained in all the provinces. It is true that values like the Saponification Value, Iodine Value, Lallement's Baryta Value, Kirschner Value or the tests for iso-oleic acid and phytosterol acetate are used in certain laboratories as supplementary tests to confirm certain doubtful results and to enable one to draw a positive or a negative inference. In our opinion, the Reichert-Meissl Value which has a range for pure butterfat from 19 to 35 is too good to be used ; instead of that, we have proposed that the so-called A- and B-values (Bertram, Bos and Verhagen) which possess a very narrow range, should be used. These Values have been found by us to be extremely satisfactory in their results. From an analysis of nearly two hundred samples of cow's and buffalo's butterfats from all provinces of India, we have ascertained that the B-value, which has a very small range, gives most reliable results. We would very much like that this be further examined by Chemists to the different Provincial Governments in India, with samples available in different provinces.

The great difficulty in the analysis of butterfat has been that the various constants of pure butterfat possess a very wide range depending upon the nature of the animal, the season and the *type of food* that is given to it. It has been our experience that the A- and B-values and especially the B-values offer the least range in the limiting values. It can be mathematically shown that whereas even a 5% adulteration of butterfat appreciably affects the B-value, the adulteration of even 20%, under similar circumstances, cannot enable the chemists with the help of Reichert-Meissl Value, etc., to draw any positive inference in pronouncing a sample as adulterated. We are not aware of any other laboratory in India where much preliminary work has been done on the application of A- and B-values for detecting the adulteration of butterfat quantitatively. Messrs. Carl Zeiss of Jena, in their most recent German pamphlet pertaining to the use of Butyro-Refractometer, have been good enough to mention the work done by us at this University as a reference book on the subject. It will be out of the place to enter into a theoretical discussion of A- and B-values in this present paper. The theoretical books on the subject of Oils and Fats have already published the necessary information.

The Reichert-Meissl Value, as adopted in India, is of doubtful Value for another reason also. Most of the vegetable and animal oils and fats (excepting cocoanut, palm-kernel and butterfat) have a Reichert-Meissl Value which is almost negligible. But Dolphin oil — a kind of fish oil — has got a high Reichert-Meissl Value of 39 to 112 with the result that if this is hydrogenated and added to butterfat (which we understand is being done), it will make the application of Reichert-Meissl Value of very little importance in pronouncing a verdict on the question of adulteration.

The application of Refractive Index, as observed in the Butyro-Refractometer of Messrs. Carl Zeiss of Jena, is from our point of view of very great importance, not merely because of the reading it gives but because of the characteristic colour-fringes which have been observed by us (in spite of the compensating prism) as also by a few of the earliest workers and which have been discussed in detail in our pamphlet, entitled *Butterfat*. We have drawn the attention of the numerous workers in this line to these characteristic colour-fringes and so far we have received no complaints to the contrary. Experiments are in progress in this University to photograph these coloured lines to show whether the sample of butter-

fat under examination is adulterated or not. The range of degrees in the Butyro-Refractometer as given by the different Provincial Governments is not in agreement with the observation which we have made and have collected in our trials of a few hundreds of samples of pure butterfat. The range which we have observed for pure butterfat at 40°C. is from 40° – 44·8° on the scale of the Butyro-Refractometer.

In some of the Provincial Laboratories (*Vide* U. P. Government standards) the observations are taken at 25° C. We fail to understand how a reading could be taken at 25° C. or why it should be taken at all at 25° C. when we know that many samples of pure butterfat have a melting point very much above 25°C. As is well known, no reading could be correctly taken in the Butyro-Refractometer unless the sample is *in a melted condition*, during the process of examination. We have found in the case of many adulterated samples that the range of melting point exceeds 44·5° C. and the characteristic colour-fringes—bluish green or orange red, etc.—betray the adulteration of the sample. For a qualitative test, which does not take more than a few minutes, we are of opinion that the observation of the Refractive Index *along with the Coloured Lines* is of great help in pronouncing an opinion on the purity of a sample.

Regarding the other Values like the Saponification Value, Iodine Value, Kirschner Value, sterols, etc. although these are valuable in themselves, we do not think that *directly* they are of much help. At best, they will render only *supplementary help*. But we would emphasise that the A- and B-values, if carried out carefully, will enable a chemist to draw perhaps the most accurate inference. The other values because of their wide range cannot be of much help unless they are all *put together*.

It is imperative in the interests of national health that a very effective legislation should be enacted to stop the adulteration of butterfat, one of the most important foodstuffs of the vegetarian dietary. But at the same time it is equally desirable in the interests of science and justice that the standards adopted in various provinces should be thoroughly examined, corrected, and re-arranged in order to protect the legitimate interests of the dealers in this article.

Centenaries in February 1936.

Gray (Stephen), 1696-1736.

FIFTEENTH of this February marks the bicentenary of the death of Stephen Gray. The exact date of his birth is not known. It is generally believed that he was born in the year 1696. What little is known about him is to be gathered only from the internal evidence contained in his contributions to the *Philosophical Transactions* of the Royal Society. He appears to have lived originally in Canterbury. But most of his experiments in Electricity appear to have been made in Charter House, where he was residing as a pensioner and in the residences of his friends, Wheeler and Godfrey.

ELECTRICS AND NON-ELECTRICS.

His first paper on electricity is the one entitled *An Account of some new Electrical Experiments* and published in 1720 in Vol. 31 of the *Philosophical Transactions*. In this paper, he added the following ten substances to the list of "Electrics" known before his time:—"(1) Feathers. (2) Hair. (3) Silk. (4) Linen. (5) Woollen. (6) Paper. (7) Leather. (8) Wood. (9) Parchment. (10) Ox-guts in which leaf-gold is beaten."

CONDUCTION OF ELECTRICITY.

His greatest discovery was that of the conduction of electricity. This discovery was made in 1729 but was published in the *Philosophical Transactions* only in 1731. "He made several attempts to carry the electric virtue in a line horizontally" and failed. At last, on June 30, 1729, "Mr. Gray went to Otterden-place, to give Mr. Wheeler a specimen of his experiments.... as also of the method and materials made use of." Giving up the nail as the supporter of the line of pack-thread, he used, as suggested by Wheeler, a silk line to support it. With this "they succeeded far beyond expectation. The first experiment was made in the matted gallery, July 2, 1729, about 10 o'clock in the morning." The experiment was repeated with success with increasing lengths of pack-thread, until they succeeded in transmitting the effect, some days later, to a distance of 765 feet.

ELECTROSTATIC INDUCTION.

The fundamental phenomenon of induction, which forms the basis of electrical condensers was first described by Gray in the same paper of 1731. Mr. Gray made his first experiment in induction on August 5, 1729 and described it as " An experiment showing that the electric virtue may be carried several ways at the same time, by a line of communication, without touching the said line."

FIRST HUMAN BEING TO BE ELECTRIFIED.

The same paper of 1731 establishes the claim that Stephen Gray was the first man to electrify a human being. On "April 8, 1730, Mr. Gray made the following experiment on a boy between 8 and 9 years of age. His weight, with his clothes on, was 47 lb. 10 oz. He suspended him in a horizontal position, by 2 hair-lines, such as clothes are dried on : they were about 13 feet long, with loops at each end. There was driven into the beam of his chamber, a pair of hooks opposite to each other ; and 2 feet from these another pair in the same manner. On these hooks the lines were suspended by their loops, so as to be in the manner of two swings, the lower parts hanging within about 2 feet from the floor of the room : then the boy was laid on these lines with his face downwards ; one of the lines being put under his breast ; the other under his thighs. Then the leaf-brass was laid on a stand, which was a round board of a foot diameter, with white paper pasted on it, supported on a pedestal a foot high, which Mr. Gray had frequently used in his experiments. The tube being rubbed, and held near his feet, without touching them, the leaf-brass was very vigorously attracted by the boy's face ; so as to rise to the height of 8, and sometimes 10 inches."

This boy and another appear to have become a permanent part of Gray's apparatus and were in constant use. Mr. Gray would no doubt have had to display considerable daring at passing, for the first time, an electrical charge through a human being. Hence an individual of only a menial status was enlisted in the cause of science. His own footboy was chosen for that honour.

A POSTHUMOUS PAPER AND A DECEPTION.

Some Electrical Experiments intended to be communicated to the Royal Society, by Mr. Stephen Gray, F.R.S., and taken from his mouth by Cromwell Martimer, M.D., R.S.Sc., February 14, 1735–36, *being the day before he died* is the title of a paper which appears in Vol. 39 of the *Philosophical Transactions.* "He told the Doctor, he had thought of these experiments only a very short time before his falling sick ; that he had not yet tried them with variety of bodies but that from what he had already seen of them which struck him with new surprise every time he repeated them, he hoped, if God would spare his life but a little longer, he should, from what these phenomena point out, bring his electrical experiments to the greatest perfection ; and he did not doubt but in a short time to be able to astonish the world with a new sort of planetarium never before thought of, and that from these experiments might be established a certain theory for accounting for the motions of the grand planetarium of the universe."

Here, however, the dying man had been deceived. The familiar conjuring trick of the goblet and the ring was wrongly attributed by him to electrical forces.

Barring this posthumous paper, Mr. Gray had contributed nearly a dozen papers on electricity, each paper being usually in the form of a descriptive account of a number of experiments on electrical conduction and induction. Gray is said to have astonished his onlookers by drawing an electric spark from the surface of water kept in a drinking glass. He used to maintain spheres and conical-shaped masses of sulphur in an electrified state for weeks and even months. Mr. Gray was essentially a pioneer and an earnest worker in experimental electricity. He richly deserves the appellation " Father of Electric Science" given him by Historians of Physics.

S. R. RANGANATHAN.

Adams (William Grylls), 1836-1915.

JUST a century after the death of the abovementioned "Father of Electrical Science," 16th February, 1836, saw the birth of W. G. Adams who advanced the sciences of Light, Electricity and Magnetism in no small measure before his death on 10th April, 1915. Adams was educated in a private school at Birkenhead and at St. John's College, Cambridge, and was subsequently elected a Fellow of that College.

In 1865 he succeeded Clark Maxwell as Professor of Natural Philosophy and Astronomy at the King's College, London and held that position till 1906. The Royal Society's *Catalogue of Scientific Papers* lists

25 papers of his in addition to a joint paper. The first paper *On the application of the screw to the floats of paddlewheels* was published in the *Philosophical Magazine* in 1865 and this constitutes his sole contribution to applied mechanics. His most famous contribution is to be found in Vol. 23 of the *Proceedings* of the Royal Society. It gives the substance of his Bakerian lecture on *The forms of equipotential curves and surfaces and lines of electric force.* He was one of the foundation members of the Physical Society of London.

The chief dates in his scientific career are the following :—

1872 Elected Fellow of the Royal Society.
1875 Delivered the Bakerian lecture.
1879 President of the Physical Society.
1880 President of the A Section of the British Association.
1883 Delivered Cantor lectures on electric lighting.
1884 President of the Institution of Electrical Engineers.

S. R. RANGANATHAN.

Obituary.

Mr. V. Ramaswami Aiyar, M.A. (1871-1936).

IT is with very deep regret that we learnt that the founder of the Indian Mathematical Society (started as the Indian Mathematical Club in 1906), Mr. V. Ramaswami Aiyar, M.A., retired Deputy Collector, suddenly passed away at Chittoor on the 22nd ultimo.

Mr. V. Ramaswami Aiyar was born in 1871 in Coimbatore district. After a brilliant educational career he served for a short time in the Central College, Bangalore and the Maharajah's College, Mysore, and (rather unfortunately for the development of mathematical research in India) he then entered the Madras Civil Service. His interest in mathematics continued unabated till his death all through his career as a revenue and judicial officer. It is even rumoured that this contributed adversely to his advancement in service. He was an outstanding example of a very enthusiastic lover of mathematical research. One of his great aims was to promote the cause of mathematical research in India. It can easily be said that he has achieved it remarkably well, considering the fact that India entered the field of mathematical research after a lapse of nearly ten centuries.

One memorable episode of his life was the discovery of Ramanujan, one of the greatest geniuses of mathematics that the world has ever produced.

The place of Mr. V. Ramaswami Aiyar in the development of mathematical research in India cannot be determined solely by the work that he produced. If he were born in an advanced western country with ample opportunities for learning under great workers with every sort of facility, he would no doubt have contributed substantial works. At least if he were a professor of mathematics in any of our universities, his great imagination, which stands forth prominently in his contributions to the so-called "Modern Geometry of the Triangle", would perhaps have been used in modern projectile geometry producing valuable results. His were days when very few people in India realised that there was mathematical research beyond the problems in Journals such as the *Educational Times*.

Perhaps his was the only example of a research worker and enthusiast in mathematics in India outside the ranks of our universities, whose interests continued unabated all through his life. We offer our sincere condolences to his bereaved family.

Letters to the Editor.

CONTENTS.

Note on the Linkage of MgO.

RECENTLY it has been shown[1] that molecules of the BeO type do not possess a double bond in the vapour state, but are singly linked only, according to the formula –Be–O–. By combination of unexcited oxygen with the excited term sp ^3P the ground state $^1\Sigma$ of the molecule is formed. Therefore its electronic configuration indicates, that only the p-electron of Be has joined electrons of O in the same quantum group, or, in the interpretation of the molecular orbital method as a pair bond theory of valency, only a single bond is produced. This interpretation of the analysis of the band spectrum has been confirmed in various ways.[2] Hund[3] has recently shown by wave-mechanical considerations, that the crystals of non-volatile insulators possess a lattice formed by true localised covalent bonds between the units of the crystal. To this class belong also BeO, ZnO, ZnS, CdS and HgS on account of their extremely high melting points and it has been pointed out[4] that this agrees indeed very well with the fact, that such molecules possess free valencies in the vapour state, being linked by a single bond only. Electronic terms with more than two free valencies lie immediately above the ground state and may easily become the lowest ones in the crystal, on account of the greater number of valencies being capable of existence and the larger amount of energy being liberated in their formation.[2] Indeed, these molecules crystallise in the zincblende and wurtzit types, which, together with that of diamond, have been taken as typical of true covalent linkage in the crystalline state for a long time.[5]

Other similar molecules, *e.g.*, MgO, CaO, etc., crystallise in the NaCl type, but they possess the same extremely high melting point and at least MgO, probably also CaO and SrO, possess the same terms and configurations in the vapour state as BeO. It would be very natural to apply the same considerations to them and to assume that such crystals are likewise formed by true chemical bonds between the lattice points. But the NaCl structure has always been considered to be the prototype of ionic linkage in the solid state. Since, however, X-ray spectroscopy obtains the geometrical arrangement of the atoms or ions in the first instance and the physical nature of the forces is inferred only by further assumptions, however plausible, it appears not to be impossible

that these crystals MgO etc. belong to the covalent non-ionic type for similar reasons as given by Hund for BeO or ZnO, in spite of the geometrical arrangement being of the NaCl type. The purpose of this note is to draw attention to such an interpretation. Even if such an assumption possesses only a remote probability and is put forward here with all reservation only, it appears interesting enough, to discuss it.

The infra-red absorption spectrum of MgO and CaO crystals has been measured some time ago by Tolksdorf[6] who finds the fundamental frequencies $\nu = 14 \cdot 2$ and $22 \cdot 05\mu$ respectively and several overtones, among them the frequencies $2\nu = 7 \cdot 65$ and $9 \cdot 75\mu$ respectively. The existence of the octave was unexpected, because, according to theoretical calculations,[7] this frequency is forbidden in the NaCl type. The field surrounding each ion in this structure, (if indeed made up of Mg^{2+} and O^{2-} ions) is completely symmetrical, the restoring force has always the same value independent of the direction and hence the law of force contains the odd powers of the displacement only. Therefore, these crystals should exhibit the odd overtones only. Indeed, Schæfer and Matossi,[8] while discussing the experimental result, surmise that "unsymmetries are produced by the electronic configuration in such a way, that two atoms each are connected in a stronger bound molecule" and assume that the regular symmetry obtains on the average. But, naturally assuming that the crystal is built up of ions, they do not pursue this idea, because similar results should then occur also in the true ionic crystals of the same type, like NaCl, where they are certainly not present.

From the point of view of band spectroscopy, the molecule NaCl is a genuine electrovalent molecule in the vapour state whereas MgO possesses a covalent bond. Whether it persists in the crystalline state, cannot be known *a priori*, but it is interesting to follow the later development of this question. On account of certain experiments of Czerny and his collaborators, Born and Blackman[9] introduced the anharmonic factor in addition to the harmonic constant and found that secondary maximas should appear in the infra-red spectrum. Barnes, Brattain and Seitz[10] come to similar conclusions by wavemechanical calculations. In any case, however, these maxima are weak and the introduction of the anharmonic constant cannot account for the appearance of two active frequencies in the gross structure. Experimentally such additional subsidiary maxima have been found not only in molecules like NaCl but also in MgO, but this fine structure has no immediate bearing on our problem. From our point of view we are only interested in the occurrence of the *main* maxima and it does not matter, whether they are accompanied by subsidiary maxima on account of the anharmonic factor, or not. Strong[11] however, investigating the far infra-red, reports a further region of selective absorption in the neighbourhood of 23μ. This is by no means double the value of $14 \cdot 2\mu$ of Tolksdorf or the double-headed maximum at $14 \cdot 8$ and $15 \cdot 3$ of Barnes, Brattain and Seitz. But considering the *gross structure* only, the experimental results of infra-red spectroscopy are not yet clear and it is not possible, definitely to correlate the measured main maxima to a fundamental vibration and the various overtones. They appear, however, much too complicated for a symmetrical cubic lattice, and they resemble much more that of the hexagonal BeO crystal with its 2 active vibrations and their overtones in the gross structure, indicating a favoured direction in the lattice. It seems therefore not impossible, that the MgO crystal is in reality a giant molecule with covalent bonds. According to the possible electronic configurations the 6 bonds, exhibited by a slightly excited term of the MgO molecule, would possess different strength, probably more than can be accounted for by the introduction of the anharmonic constant in the second approximation. This would explain the complicated structure of the infra-red spectrum, the existence of several main maxima and also, why the vibrations lie at about 23μ and the new "octave" at about 15μ.

In the present unsatisfactory state of knowledge as to the experimental facts, this is of course a mere assumption, and we only want to draw attention to such a possibility, because it would agree with the wave-mechanical considerations on the structures of non-volatile insulators and the conclusions of band spectroscopy. It is a matter of personal opinion, whether these arguments are already sufficient, to modify the viewpoint, based on X-ray spectroscopy, that the NaCl structure is a rigorously valid criterion of electrovalent linkage. In this connection, however, attention should be

drawn to the fact, that the same geometrical arrangement may be exhibited in cases, in which the nature of the bonding forces is certainly quite different. As typical examples we may consider again the double salts (KF, MgF_2) or (CsCl, $CdCl_2$) which crystallise with the same structure as KIO_3. There exists doubtless a MgF_3 or $CdCl_3$ group in the crystal in the geometrical sense, similar to the IO_3 group, but only the latter one is a chemical individual, preserving its entity, for instance in solution. It exists on account of the heptavalency of iodine, which possesses seven outside electrons, whereas a trivalency of Mg or Cd are out of question ; the existence of the MgF_3 group is due to the formation of a mixed crystal (solid solution) which mostly decompose at lower temperatures. Thus the linkage inside the MgF_3 and IO_3 group are entirely different. Similarly SiO_2 (in β-tridymite) possesses the same structure as ice. But H_2O is a saturated molecule and forms therefore a volatile molecular lattice, in which the individual water molecules are connected with each other by Van der Waal's forces only, whereas SiO_2 is a typical non-volatile insulator, each Si atom is linked to four O atoms, each O atom to two Si atoms, and all these bonds are true covalent linkages. Such examples make it easier to understand, that the crystal lattice as such is not necessarily a rigorously valid criterion as to the nature of the physical forces. The crystal is always formed with that structure, which, under the particular conditions, exhibits the minimum of energy and therefore the same few arrangements of high geometrical symmetry obtain always, independent on the type of linkage. Among the necessary conditions for a particular structure those of a geometrical nature, as for instance the ratio of the atomic radii predominate again over those of a more physical nature, *e.g.*, the polarisibility of the ions. It appears therefore quite conceivable, that the oxides of Mg and Ca belong in reality to the type of giant molecules, *i.e.*, non-volatile insulators, with true covalent bonds linking the units of the lattice, even at a sacrifice of the conception of the NaCl structure as a criterion of ionic linkage.

H. LESSHEIM.
R. SAMUEL.

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[3] F. Hund, *Z. Phys.*, 1932, **74**, **1** ; Report "Intern. Conference, 1934", *Physic. Soc. London*, 1935, Vol. 2, p. 36.

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[7] C. J. Brester, *Diss. Utrecht*, 1923 ; *Z. Phys.*, 1924, **24**, 334.

[8] Cl. Schæfer and F. Matossi, *Das ultrarote Spectrum.* Berlin, 1930, p. 309 ff.

[9] M. Born and M. Blackman, *Z. Phys.*, 1933, **82**, 551; M. Blackman, *Z. Phys.*, 1933, **86**, 421.

[10] R. B. Barnes, R. R. Brattain and F. Seitz, *Phys. Rev.*, 1935, **48**, 582 and earlier.

[11] Strong, *Phys. Rev*, 1931, **37**, 1565.

The Iso-electric Point of Vitamin B_1.

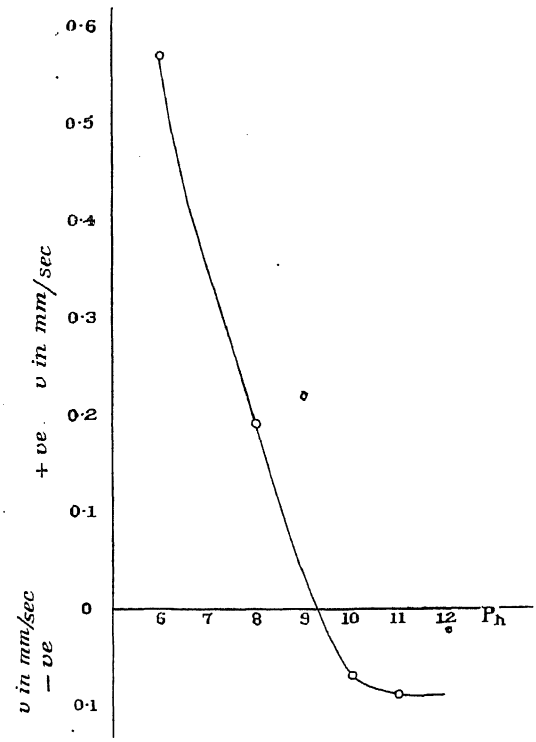
STUDY of the behaviour of vitamin B_1 in an electric field at different levels of hydrogen-ion concentration assists in elucidating its chemical nature. Previous attempts have been made to determine the iso-electric point of the vitamin (Birch and Guha,[1] 1931 ; Sankaran and De,[2] 1934 ; Ghosh and Guha,[3] 1935). Sankaran and De reported that the iso-electric point is in the acid range (pH 3·0) while Guha and his collaborators found it to be in the alkaline range at pH 8·5. These discordant results may be ascribed to the use of impure vitamin B_1 preparations ; further, the values obtained were not confirmed by satisfactory biological tests.

I have recently reinvestigated the problem by the method of electrophoresis, using crystalline vitamin B_1 prepared according to the method of Kinnersley and Peters,[4] (1933). Electrical migration experiments, with suitable voltage and current strength, were carried out at 6 levels of pH, with solutions containing 300 γ of vitamin B_1 and the contents of the pole chambers tested chemically for vitamin B_1 (Peters *et al*, 1934).[5] The results were as follows :

pH	Quantity of B_1 migrating towards		Nature of charge of B_1
	Positive Pole	Negative Pole	
5·8	0·0 γ	75 γ	+ ve
8·0	0·0 ,,	120 ,,	+ ve
9·0	0·0 ,,	31·9 ,,	+ ve
10·0	44·0 ,,	21·0 ,,	± ve
11·0	30·0 ,,	0·0 ,,	− ve
12·9	114·0 ,,	0·0 ,,	− ve

The above values are calculated for the same strength of current. The contents of the various chambers were tested biologically by feeding them to polyneuritic pigeons, and the biological test gave results in substantial agreement with those obtained by chemical assay.

The same problem was further studied by the method of micro-cataphoresis, using the Brown and Broom cell as modified by Millwood.[6] The migration velocity of Kieselguhr particles was determined at various levels of pH — (*a*) without vitamin B_1, (*b*) with the vitamin adsorbed on the particles. The difference in velocity so observed was calculated with due attention to the sign of the charge. The results are shown graphically in the following figure, in which the



ordinates represent the change in velocity produced by the vitamin, and the abscissæ various values of pH. The velocities are in mm./sec. with a current strength of 1 milliamp. and voltage 220 acting between poles 16 cms. apart.

The results of the micro-cataphoresis experiments indicate that the iso-electric point lies between pH 9 and 10, nearer 9 than 10. From the graph its location appears to be at about pH 9·2.

Full details of these experiments will be published in the *Indian Journal of Medical Research*.

G. NARASIMHAMURTHY.
Nutrition Research Laboratories,
Coonoor.
February 5, 1936.

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[2] Sankaran, G., and De, N. K., *Ind. Jour. Med. Res.*, Oct. 1934, **22**, No. 2, 233.
[3] Ghosh, A. C., and Guha, B. C., *Curr. Sci.*, May 1935, **3**, 555.
[4] Kinnersley, H. W., *et al.*, *Biochem. J.*, 1933, **27**, No. **1**, 225.
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[6] Brown, H. C., and Broom. J. C., '*System of Bacteriol*', 1931, **9**, 278.

Identity of Noroxylin with Baicalein.

IN continuation of our previous letter on the constitution of Oroxylin[1] we have now confirmed our conclusion that noroxylin is baicalein by means of a mixed melting point determination with an authentic sample of baicalein kindly supplied by Professor Keita Shibata. There would seem to be no doubt, therefore, that oroxylin is the 6-methyl ether of baicalein.

R. C. SHAH.
C. R. MEHTA.
T. S. WHEELER.
Royal Institute of Science,
Bombay,
February 12, 1936.

[1] *Curr. Sci.*, 1935, **4**, 406.

Pollen Grains in the Stylar Canal and in the Ovary of an Angiosperm.

IN a letter to *Nature* last August Mr. B. M. Johri[3] of Agra announced the discovery of pollen grains lying inside the stylar canal, and in one case even inside the ovary, of an angiosperm, *Butomopsis lanceolata* Kunth. An outline sketch of a longitudinal section of the ovary shows that *the stylar canal opens to the exterior through the stigma*. There is a row of five pollen grains arrested in the upper part of the canal, the diameter of which, according to the sketch published, is about $1\frac{1}{2}$ to 2 times as large as that of the spores. The pollen found in the ovary was not figured. As the full description is not yet available one cannot say whether these pollen grains belonged to the species in whose ovary they were found.

Mr. Johri states that "in one case a pollen grain had germinated and sent out a small pollen tube", but he does not say whether this pollen grain was in the stylar canal or in the ovary. The fact that it had put out a pollen tube, although interesting, is no proof that it was not a "foreign" spore;[6] Mr. Johri will no doubt clear this point in the full paper. "Usually the pollen grains germinate on the stigma."

The development of the female gametophyte has interesting features of its own, but to the present writer the pollination phenomena briefly described by Mr. Johri seem to surpass them in importance. For, whether the pollen grains found in the ovary and stylar canal belong to *Butomopsis* or not, their occurrence in these positions, even though occasional, is a distinctly gymnospermous feature. It seems impossible to explain the entry of these spores, even into the upper part of the canal, except on the assumption that they were drawn in by some sort of suction mechanism like that of the "stigmatic drop" of gymnosperms, the stylar canal functioning like a micropyle.

One is at once reminded of Professor T. M. Harris's recent discovery, (which obviously deserves wider notice) of pollen grains inside the supposed "angiospermic" fruit of a new species of *Caytonia*, *C. Thomasi* T. M. Harris.[1,2] Professor Harris (1933) has figured preparations, some of which I have had the privilege of examining in his laboratory, and which leave no room for doubt that at least at pollination time the fruits were not closed. The ovules were open to access by pollen grains, as in the gymnosperms. Harris writes that "the considerable majority of well-preserved seeds........possess pollen grains........ in their micropyle", while "practically no pollen grains (apart from those in micropyles) occur in the interior of the fruit". From the appearance of cuticular preparations of the stigma and fruit, both in *C. Sewardi* and *C. Thomasi*, it is inferred that the pollen grains gained access to the micropyles through definitely organised canals, at the tips of which the spores were probably caught in "stigmatic drops" secreted by the ovules.

One might imagine some such result if the incurved ovuliferous organ of a *Stachyotaxus* or of a *Palissya*-like gymnosperm were to become completely doubled upon itself, the opposing inner surfaces leaving only narrow chinks between them for the ingress of pollen. However that may be, Harris's discovery on the one hand, and Johri's on the other, are enough to set one thinking, to say the least. Either we must relax our definition of an angiosperm, or we must be prepared to agree that *Caytonia*, at least, is not yet quite an angiosperm! And if you thus make a breach in the supposed angiospermy[7,8] of the Caytoniales through the perforated ovary of their type genus, who knows what is in store for *Gristhorpia* and the rest? Indeed, Harris's 1933 work (p. 112) tends to make it possible that the difference between *Caytonia* and *Gristhorpia* may not be of generic rank.

Now, if the mode of pollination in *Caytonia* is to bring that genus within the gymnosperm fold, where Prof. Kräusel had already placed the whole group,[5] what of *Butomopsis*, an undoubted angiosperm, and a monocotyledon at that? Shall we say that it has retained the open stylar canal, postulated by Professor Harris (p. 108) for the primitive angiosperms? This seems to be the only natural and reasonable conclusion, although it is opposed to Mr. A. C. Joshi's attractive theory (1934) that the stylar canal of angiosperms owes its origin to the disintegration of a vascular tract in the carpel.[4]

The whole question is very intriguing, and we obviously need more facts, covering a wider field; but Mr. Johri deserves thanks for bringing to notice what can only be regarded as a relic of gymnospermy in a confirmed and unquestionable angiosperm. It is not unlikely that many other instances of the kind have passed unnoticed, because modern workers on angiosperm life-histories do not so often investigate the styles and stigmas as it seems they should, and no doubt will do in future, with the recent revival in carpel studies.

Dr. Hamshaw Thomas's work on the Caytoniales will always remain a classic of palæobotanical investigation, in which the possibilities of cuticular technique were demonstrated in a brilliant manner. Although one need not stand committed to all his theoretical conclusions he has certainly shown an *approach* to angiospermy,[9] and has set others on the quest.*

The University, Lucknow. B. SAHNI.
January 18, 1936.

* Since my note on pollen grains was communicated Mr. Johri of Agra has kindly shown me

some of his selections. I am satisfied that the pollen grains figured by him in the stylar canal belong to the *Butomopsis*: they are identical in character with the pollen grains found in the anthers of this plant. I have not seen the sections showing pollen grains inside the ovary, but there is no reason to doubt the accuracy of his observation. These observations should be worthy of a detailed record even if the pollen grains were "foreign". Mr. Johri's full paper may be awaited with interest.

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[2] Harris, T. M., "A new member of the Caytoniales," *New Phyt.*, 1933, **33**, 97-114.

[3] Johri, B. M., "Life-history of *Butomopsis lanceolata* Kunth," *Nature*, 1935, **136**, 338.

[4] Joshi, A.C., "Morphology of the stylar canal in angiosperms," *Ann. of Bot.*, 1934, **48**, 967-974.

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[8] Thomas, H. Hamshaw, "The early evolution of the angiosperms," *Ann. of Bot.*, 1931, **45**, 652, 654.

[9] Thomas, H. Hamshaw, "The nature and origin of the stigma," *New Phyt.*, 1934, **33**, 173-198.

With reference to the above note of Prof. B. Sahni, a copy of which was kindly shown to me about a week after it had been sent to the press, I think it necessary to make the following remarks. The necessary figures and some other interesting details will be found in my full paper which will soon appear elsewhere.

1. In the stylar canal of one carpel there was a row of six pollen grains of which five could be seen in a single section. It is this that was figured in the note published by me in *Nature*. The pollen grains are approximately 24 microns in diameter and the stylar canal is $1\frac{1}{2}$ to 2 times as wide.

2. In a dozen other cases (from three different flowers) pollen grains were found *inside the ovary*. One of these was located on the surface of an ovule (which was unfortunately cut obliquely) and had actually germinated, although the pollen tube was very short.

The writer was himself greatly surprised when he saw these pollen grains in such unexpected quarters and a careful examination of their size and nuclear contents left no doubt whatever that they *belonged to the same species*.

Before entering into a detailed discussion of the theoretical bearings of this discovery, the writer wished to be sure whether a similar thing had been observed before in any other plant. An enquiry from Prof. K. Schnarf of Vienna brought forth the reply last month, that the phenomenon was absolutely unique and had never been noticed by him in the existing literature on Angiosperms.

As Prof. Sahni has pointed out, the occurrence of pollen grains inside the ovary of an undoubted angiosperm like *Butomopsis*, sets one thinking about the difference between a Gymnosperm and an Angiosperm. *Caytonia Thomasi* provides material for comparison and speculation; and so does *Gnetum*, if we agree to designate the inner envelope as a stylar canal and not as an integument.

B. M. JOHRI.

Botany Department,
Agra College, Agra,
February 1, 1936.

Chromosome Numbers in *Phœnix farinifera*, Roxb.

TWENTY-ONE species of *Phœnix* have been enumerated in the *Index Kewensis*; of these, five species are natives of South India. The chromosome numbers of the various species are not available except for the cultivated date palm—*Phœnix dactylifera*, Linn. Nemec (1910) gives the $2n$ number as 28.

The author of the present note has, from several counts made in the metaphase plates of pollen mother-cells, determined the haploid (n) number of chromosomes in *Phœnix farinifera*, Roxb. (common on the east coast of the Peninsula) as 18.

G. V. NARAYANA.

Oil Seeds Section,
Agricultural Research Institute,
Coimbatore,
January 6, 1936.

Ram Sarcophagus from Cuddappah.

WITH reference to Mr. M. D. Raghavan's article on "A Ram Sarcophagus from Cuddappah" appearing in 1935, November issue of *Current Science*, the following observations may be of interest.

After seeing the object in the Madras Museum and after examining its detachable head carefully, I find myself unable to

agree to the author's statement that the "Ram's head is clearly modelled". Except for what the author calls "the curling horns", I fail to find anything to warrant the conclusion that the object is a clear model of a ram's head. On the other hand, the slightly curving and tapering facial portion and the omission of the ears (especially when the artist has taken pains to mark the position of the comparatively smaller eyes and the nasal holes) seem to suggest that the maker intended this removable head portion of the sarcophagus to represent a hovering bird (perhaps a Vulture) and not the head of a ram. If it represents a hovering bird, then the "curling horns" may be taken to represent a pair of sturdy wings. Again this part of the sarcophagus is so small and suits so ill the rest of it from the point of view of proportion, that it raises in my mind the doubt, whether the person who made the object ever meant this sarcophagus to represent a ram. The presence of the six legs adds colour to this doubt.

Composite objects are not uncommon in pre-historic archæology. It seems to me to be more reasonable to call this sarcophagus a composite object than to christen it a "ram sarcophagus". It may be a fantastic representation of some mythological figure associated with death that loomed large in the minds of those pastoral people. One must remember that the big, the unnatural, the grotesque and the unknown appealed to the primitive mind more than anything else and the primitive man made attempts whenever he had opportunities to represent his imaginary pictures of these in his handicrafts.

Further on in the article the author makes mention that this sarcophagus is the second "funerary vessel in animal form known from South India". This is incorrect. The Superintendent of Archæology, Cochin State, in his annual report of the Archæological Department of the Cochin State for the year 1109 M. E. (1933-34 A.D.) mentions that a sarcophagus which has "the appearance of a cow in a lying posture" was discovered at Kattakampal in the year 1933-1934. This report was published a few months before or very shortly after this supposed "Ram Sarcophagus" was unearthed.

K. GOVINDA MENON.

Madras,
February 5, 1936.

The Mineral Bababudanite—An Explanation.

IN my reply to Mr. M. B. Ramachandra Rao's letter entitled "The Kaldurga Conglomerates and the Iron Ore Series of the Bababudans, Kadur District, Mysore," published in this *Journal* (Dec. 1935), I am afraid I have not made myself quite clear in my remarks regarding the origin of the mineral bababudanite when I said "my colleague, M. R. Srinivasa Rao, and I were the first to point out that the mineral was developed as a result of thermal metamorphism." The intention at the time of writing this was not what this statement would literally imply, for I was aware that Jayaram had suggested the secondary nature of bababudanite and I have myself referred to it in one of my papers.[1] What was intended to be claimed was, that the exact nature of the rocks involved in the process of metamorphism giving rise to bababudanite, was elucidated for the first time in the course of my work.

CHARLES S. PICHAMUTHU.

Central College,
Bangalore,
February 5, 1936.

[1] C. S. Pichamuthu, *Curr. Sci.*, 1935, **3**, 608.

Mathematics and the Sciences.

THE review of *Descriptive Mathematics* on page 556 of the January number of *Current Science* demands comment. The book reviewed is *not* a companion volume to *Graphs and Statistics*, though a contrast to it. Nor is it a book for "statisticians whose background of mathematics is negligible"; if it were so, why the title *Descriptive Mathematics*? Your reviewer seems to have got nowhere near the standpoint of the book. One difficulty seems to be that the unique situation we enjoy here in Bombay is not appreciated—it is possible for us to act in making striking departures from the ordinary courses in elementary College mathematics without taking the whole body of teachers with us immediately. *Descriptive Mathematics* is an endeavour to define such a departure, not to popularise it; but the standards your reviewer appears to have applied in valuing the book are quite conventional. He merely thinks of students as they are, and not as they might be were they successfully led through such a course as is proposed. He seems, so far as his ideas are clear, to differ in no essential respect from

those who were expected, according to the preface of the book, to look askance at certain methods used and to say that the thing proposed could not be done.

But the plain fact is that something needs to be done. Not a few specialists in economics and in the biological sciences feel the necessity of stopping to prepare courses in elementary statistics, etc., for the benefit of their colleagues in order to deal more effectively with the problems of their own researches. These courses, applicable in subjects ranging from textiles to physiology, have a very great deal in common. Again, inept use, or the avoidance, of elementary mathematics in the physical sciences could be abundantly illustrated. These are, I think, but indications of a misdirection in the general outlook on mathematics; and certainly the ordinary courses in mathematics meet such needs not even in an indirect way. We cannot long continue to ignore this defect in our educational practice, and a first task must be to discuss the lines along which we should move away from the present mathematical courses. In *Descriptive Mathematics* is a definite proposal to this end for first year students only, not for the second (Intermediate) year; but your reviewer can see nothing new in it, and merely judges it from a conservative standpoint. (To take one simple instance: I should like to know if there be anywhere else an examination of the principles of slide rules comparable with that on page 97.) When we have achieved a reasonable measure of agreement as to what aspects of elementary mathematics should be taught, there will be no lack of endeavours to write books suited to examination purposes. But that is not the criterion to apply at this stage.

JOHN MACLEAN.

Wilson College, Bombay,
February 2, 1936.

I HAVE perused Prof. Maclean's comment. Prof. Maclean is a distinguished educationist of Bombay and we have high respect for his services to the cause of education. But so far as his present book is concerned, I cannot help expressing my frank and honest opinion without any reservations. I shall not worry myself about this charge of conservatism on my part, but I shall dwell with emphasis on one point only:

The average man has a general dislike for or difficulty to follow the theory of mathematics. It must be the endeavour of every mathematics teacher of the elementary stage to present the subject with as much simplicity as possible, confining in the earlier stages only to the *intrinsic beauty* of the subject, omitting all details and complications to a later stage. To most people, even to many mathematicians themselves, numerical work and heavy calculations are disgusting. From the boy at school who works on vulgar fractions and decimals, to the average public man, heavy arithmetic is never taken as matter of love. This is a general human weakness, and not all the slide rules in the world can remedy this to any remarkable extent. If then heavy numerical work is taken as a necessary adjunct to the elementary principles and methods of mathematics, and the result of this fusion is called *Descriptive Mathematics*, it is my frank opinion that most people would bid good-bye to this kind of mathematics. Experimental Scientists, and research workers in Social Sciences require and will automatically cultivate the required speed and accuracy in numerical work, when they settle down at their work, but to inflict this kind of work on a poor First Year Intermediate student is horrible!

I remember our learned Editor of the *Current Science*, in the course of a speech somewhere saying to the following effect: To the Physicist, everything in this world will appear as Physics and Chemistry, to the Biologist, everything will appear as Biology, etc. Likewise, shall I say that a Statistician cannot *describe* simple elementary principles of mathematics without asking his boys

(1) to use the slide rule and verify

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2} \frac{\sqrt{(2+\sqrt{2})}}{2} \frac{\sqrt{\{2+\sqrt{(2+\sqrt{2})}\}}}{2}$$

(2) to draw the curve $y = 1320x^{-0 \cdot 0234}$

(3) to solve $10000 \ (\sin 3x + 2\frac{1}{2} \cos 2x) = x^2 - 300x + 9000$?

These are a few specimens from the book.

I have no personal dislike for statistics and I have some little pretensions for the subject myself; I can also boast myself to be a moderately good computer. But there is a difference between having a knack for this work or cultivating it as one's needs arise, and gulping this down on a poor Intermediate student.

One can see in Prof. Maclean's book in many places the hand of an experienced and able exponent of the subject, but in my

opinion this is marred by an over-filling of numerical work.

Here are two specimens (not typical, though) of *Descriptive Mathematics* :—

(*a*) "On March 21 the number of seconds taken by the sun to cross the horizon in latitude l is 32/15 sec l; find this for $l = 19°$ and $l = 60°$" (p. 58).

Is this illustration going to create a new interest in the student for the secant function, or is it going to be the nucleus of his future astronomical studies, or does it just show off the pedantry of the author?

(*b*) "Note sets of words like "due, duty, dutifully" which are useful in teaching time in music. The periods of the syllables of these words are as 4 : 2 : 1. Consider the possibility that rhythm in speech and in prose may be partly and automatically determined by the essential periods and intensities of syllables. (In poetic rhythm there is of course deliberate selection of combinations of syllables)". (p. 60.)

This example follows problems like sketching the curves corresponding to $\cos^2 x$, $\cos^3 x$, etc. I have no music in me, but frankly, this piece of mathematics is beyond me.

C. N. S.

Research Notes.

On Ternions in Geometry.

HANS BECK (*Math. Zeit.*, **40**, 4, pp. 509-520) has investigated the occurrence of the linear transformation group of the system of non-commutative ternions, under various forms in several places in geometry. Let A, B, C, D be four ternions, then the linear transformation is $X' = (Cx + D)^{-1} (Ax + B)$. Now it is known that apart from the non-commutative system of the ternions, there exist two other commutative systems of ternions. In the latter cases, the linear transformation-group reduces itself to one of nine parameters. This is not of so much importance as the group in the non-commutative case, of eleven proper parameters. Beck has shown that this group occurs in the following places in geometry: (1) A special collineation group of a linear-complex; (2) A cremona group in affine space; (3) The group of Laguerre transformations of directed planes; and (4) The group of rotations (in the same sense) in the four dimensional Euclidean space, etc.

A ternion of the system is represented as $A = A_0E_0 + A_1E_1 + A_2E_2$ and the multiplication table is

$$\begin{vmatrix} E_0 & E_1 & E_2 \\ E_1 & E_0 & E_2 \\ E_2 & -E_2 & O_0 \end{vmatrix}$$

E_0 can be taken to be the scalar unit. The norm $N(A) = A_0^2 - A_1^2$ (Hence reducible). If ξ_0, ξ_1, ξ_2, ξ_3 are the co-ordinates of a point in a projective R_3 and the Plucker's co-ordinates of a line are $P_{ik} = \xi_i \eta_k - \eta_i \xi_k$, then the ternions A, can be made to correspond to the lines of R_3 with co-ordinates $P_{01} : P_{02} : P_{03} : P_{23} : P_{31} : P_{12} = 0 : 1 : A_0 - A_1 : A_2 : -(A_0^2 - A_1^2) : (A_0 + A_1)$. (The transformation is not one-one.) By means of this transformation he has shown that the group is identical with the collineation which transforms $\xi_0 = 0$, $\xi_1 = 0$ into itself. Here is a nice geometrical representation of ternions.

He has also shown that the group is holomorphic with the group of the minimal complex—the straight lines having proper intersection with the conic-absolute in an Euclidean R_3.

The first representation of ternions is such that an ∞^2 st. lines of the projective space R_3 did not correspond to ternions at all. Then by considering a geometrical entity as corresponding to a ratio of two ternions, he obtains a representation in which the geometrical entities are points in an affine space; the exceptional points for which ratio of ternions do not correspond belong to a plane which is naturally considered as the special-plane of the affine space (*Uneigentliche-Ebene*). The work is a very striking illustration of the unity in geometry stressed by Klein in his epoch-making Erlangen-Programme.

K. V. I.

Cauchy-Riemann Conditions.

MENCHOFF (*Fund. Math.* **25**, pp. 59-97) has extended Looman's classic result (*Gott. Nach.*, 1923) about the sufficient conditions for the analyticity of $f(z) = P + iQ$ in a given simply connected region. Looman had shown that if the Cauchy-Riemann partial differential equations were valid for almost all points in the region then $f(z)$ was analytic. This amounted to assuming that the derivates in two perpendicular directions (directions same

(*Continued on page 605*)

SUPPLEMENT TO "CURRENT SCIENCE".

Reviews.

An Examination of Examinations. By Sir Phillip Hartog and E. C. Rhodes, D.Sc. (Macmillan and Co., London, 1935.) Pp. 81. Price 1*sh*. net.

The publication of a book called '*An Examination of Examinations*' by Sir Phillip Hartog and Dr. E. C. Rhodes (Macmillan & Co.) has caused considerable commotion in the educational world. The history of the matter goes back to 1931, when, at the instance of the Carnegie Corporation, the Carnegie Foundation and the International Institute of Columbia University, Committees were set up in England, Scotland, Switzerland, France and Germany. These Committees were each financed with a grant for three years, and were requested to carry out investigations regarding examinations on whatever lines seemed best to them. The English Committee was presided over by Sir Michael Sadler, and consisted of educational experts of admitted authority. It determined to compare the marking of the same sets of examination answers by different examiners. The volume under review is an account of the main findings of the English Committee, and the reviews of the book already published in England are unanimous in describing the results of the enquiry as disquieting. Now that this investigation has been made, and its results published, the really surprising thing would seem to be the fact that such an investigation has been so long delayed. Those engaged in educational work have for long been aware that examinations were not a perfect test of the ability of candidates. Sir Phillip Hartog reminds us that at Oxford nearly fifty years ago, Professor Edgeworth conducted a small test concerned with the valuation of a piece of Latin prose by a number of different examiners. The results showed a variation of over fifty per cent. between the highest and the lowest marks awarded. In 1911 Sir Phillip Hartog himself in a lecture given before the Royal Society of Arts recommended that a Royal Commission should be set up to investigate the examination system in Great Britain. Until the work of the recent Committee of enquiry, however, nothing systematic appears to have been done.

In order to carry out their enquiry, the Committee enlisted the sympathy and services of various examining bodies in England. From them it received actual scripts written by candidates for different public examinations. After noting the numerical value assigned by the original examiners, every mark was removed from the scripts. The services of an independent body of expert valuers were then enlisted. These people were in every case persons accustomed for years to value examination papers of the type being investigated. Each of a number of examiners was then asked to value the selected scripts, and the volume under review is an account of the results obtained from this valuation. The Committee selected examinations of widely differing types and standards, in order to test valuation at different stages of the educational process. They selected—

1. *The Special Place Examinations.*

These examinations are held for candidates between the ages of 10 and 12, and on their results children in Elementary Schools gain admittance to Central Schools or Secondary Schools. The importance of this examination to children in England will be evident, when it is realised that the number of candidates every year is estimated to be nearly half-a-million.

2. *The School Certificate Examinations.*

These examinations are conducted by several different bodies in England, and are taken by nearly 70 thousand candidates every year. The average age of the candidates is about 16. Under certain conditions, the passing of this examination qualifies for entrance to the Universities. It may truthfully be said that a boy who is unable to pass this examination is in the vast majority of cases condemned to a poorly paid and subordinate post for the rest of his life.

3. *A College Scholarship Examination in English Essay at one of the Older Universities.*
4. *A University Honours Examination in Mathematics.*
5. *A University Honours Examination in History.*

From the foregoing, it will be seen that the Committee has tested the examination

system at many stages. In the space of a short review, it is not possible to give the detailed findings regarding each of these examinations, but no one engaged in educational work can afford to be ignorant of the information contained in *An Examination of Examinations*. As a sample of the findings of the Committee, we may select the School Certificate Examination in History, as the results in this case display, perhaps, the greatest disparities. Fifteen scripts were selected, all of which had been given the same "middling" mark by a certain English examining authority. The cleaned scripts were sent to fifteen examiners all of whom were in the habit of valuing papers for examinations of this standard. These fifteen examiners awarded no less than 43 different marks, the lowest mark assigned being 21% and the highest 70%. This result is sufficiently disturbing, but worse follows. After an interval of not less than a year, and not more than 19 months, the same scripts were cleaned again, and sent to the same examiners, who were not however, informed of the fact that they were being asked to value the same papers a second time. The result of the re-examination was that the total number of different marks assigned was 44 and the percentage varied from 16 to 71. It was found that nearly half the examiners give a different verdict on each candidate on the second occasion, and one examiner changed his opinion in regard to no less than 8 candidates out of the 15. The astonishing thing about this particular examiner was that he only varied his average mark per candidate by a unit, and that in each batch of 15 scripts, he awarded the identical number of failures. As Sir Phillip Hartog and Dr. E. C. Rhodes point out, such irregularity of judgment is not only formidable, but it is one which would never be detected by any ordinary analysis of valuation results. Statistically this examiner produced almost identical results on both occasions, but the fate he allotted to half the candidates was different. Of all the valuers engaged in this particular examination, only one was exceptionally steady, and his maximum variation between the two valuations was 7%.

Although the results in the other examinations showed smaller discrepancies than in the case quoted above, there was no examination which did not reveal disturbing differences of opinion. Every one will at once ask the question: Should examinations be abolished? The Committee who conducted these investigations answer emphatically in the negative and are of the opinion that examinations as a test of efficiency are necessary, and that no satisfactory substitute can be found for them. Careful and systematic experiments, they point out, will be necessary in order to devise a system of examination valuation which will not be liable to the evident uncertainties of the present system. The President of the Board of Education in Great Britain in reply to a question on 9th December last in the House of Commons, stated that "the Report of the Committee raises questions of great importance that call for and will at once receive full investigation by my department."

During the last decade or more, there has been a marked increase in England in the *viva voce* (Interview) examination. It has been steadily maintained that this test (which is not a *viva voce* on any particular subject) affords a trustworthy opinion of the alertness, intelligence and general outlook of candidates. This interview examination (for which marks are allotted, for example, in the Indian Civil Service Examination, and in that for the Class I Administrative appointments in the British Civil Service) has become more and more popular for all kinds of appointments both public and private. There have, however, always been people, who refused to believe that the interview examination produced the results claimed for it by its enthusiastic advocates. The Committee whose work we are reviewing conducted an examination of this kind. It constituted two such Boards of Examiners. We are not told the names of those who made up the two separate Boards. We are, however, given the list of names of those from whom both Boards were made up. Their names command respect in England, and their competence to fulfil the functions assigned to them would be unquestioned by any one. Despite this fact, Board I examined 16 candidates and selected one as deserving of the first place. This candidate was placed 13th, however, by Board II, its first candidate being placed 11th by Board I.

We have not exaggerated in stating that the results of this enquiry into examinations are disquieting. It is well, however, to preserve a sense of balance, and a little

reflection will show that these results after all merely serve to prove a fact which should be self-evident, namely, the fallibility of all human judgment. Higher Law Courts are constantly reversing the judgments of Lower Courts on appeal. In medicine, the highly qualified specialist will not invariably diagnose a case in the same way as the general practitioner. There is, in fact, no walk of life in which different men will not give different judgments concerning matters on which all are theoretically competent. This being so, we need not be surprised that '*An Examination of Examinations*' has revealed discrepancies in human judgment. The present writer has always felt that examiners should be more carefully selected. It should not be assumed that one who has a competent knowledge of his subject and is a successful teacher of it, is necessarily possessed of that calm balanced type of mind so necessary to enable an examiner to maintain a fair and even standard. It would, at the moment, be obviously a difficult and most delicate matter to subject prospective examiners to a test as to their fitness, but the time may come when such tests will be an accepted part of the machinery of the educational world. India will await with interest the consequences in England of the present enquiry. It seems clear that matters can no longer be left exactly where they are.

E. M.

Marine Zoogeography. *Tiergeographie des Meeres* (Akademische Verlagsgesellschaft, Leipzig, 1935). Pp. 542, 32 Marks.

Prof. Sven Ekman of the University of Uppsala, Sweden, has made a very valuable contribution to biological literature by the publication of his masterly work entitled *Tiergeographie des Meeres*.

The Zoogeography of earth's surface has been dealt with by various specialists, and there are available a large number of excellent publications which contain not only detailed and critical accounts of land faunas, their origins, relationships and distributions, but also deal with the conditions governing life, adaptations of different animals, animal communities, their ecology, etc. In reference to marine faunas, however, the earlier works of even such authorities as Schmarda, Agassiz, Dana, Woodward and Günther, unfortunately lack in some very essential points. In 1896 the masterly volume of Ortmann—*Grundzüge der marinen Tiergeographie*—laid the foundations for detailed marine zoogeographical studies. In this book, Ortmann not only defined the zoogeographical regions into which the oceanic area can be divided, but also discussed the physical conditions governing life in the different regions, the various factors determining the conditions of life in different areas, the *Bionomie*, the peculiarities of the conditions of existence (Moseley) and the adaptations of the organisms for existence in the different *milieus*. In discussing the distribution of the sea animals he dealt with the factors which control and hinder distribution, as also the agencies which govern the distribution of the various organisms. The influence of the geological changes of the earth's surface on the distribution of animals in the different oceans and the changes in climatic, topographical and biological factors for the distribution of the animals were also discussed. Ortmann finally considered in detail the Bionomie and the present-day geographical distribution of the Decapod Crabs, and briefly reviewed the distribution of other marine organisms as determined by the various controlling agencies detailed above. Similar but more fragmentary accounts of the distribution of marine organisms are also to be found in oceanographical works such as *Science of the Sea* (Second edition, edited by E. J. Allen, 1928), but as Ekman points out, no work is available in which one can find a comprehensive account of our knowledge of marine zoogeography.

The first ten chapters of the work under review deal with the faunas of the different oceanic areas, their origins, relationships, compositions, etc. In view of the great importance of this part of the subject a somewhat detailed summary of these chapters is given below. The remaining six chapters deal with the "Meridiane Verbreitung" or the distributions of special genera or species along definite meridians of longitude or latitude, Bipolarity problem; Benthal Deep-sea Fauna, its composition, conditions governing its existence, regional distribution, and origin; and the Pelagic Fauna of the upper and deeper layers, its horizontal distribution, its relationships to salinity, etc. In the final chapter are discussed the adaptations of animals to deep-sea life, such as the development of special light organs, special enlargement, or reduction in the size of eyes culminating in the animals becoming absolutely

blind, uniform colouration and the enlargement of the mouth opening, special development of teeth, increase in the size of stomach, taste-organs, prolongation of antennæ, fin-rays, etc. The horizontal distribution of the bathypelagic fauna and its origin are also discussed.

In conclusion the author remarks that the geographical distribution of the organic world seems to be determined by the physiological peculiarities of the animals as regulated by the chemico-physical reactions of the surrounding world. Evolution along divergent lines in widely separated localities is the essence of biogeographical distribution and its earlier manifestations are the discontinuity in the distribution of different classes of animals in adjacent areas.

In connection with the present-day disposition of the faunas of different areas modern work has clearly brought out the importance not only of studies regarding the influence of organic evolution but also of the changes in the earth's surface and climate during the past geological epochs. As a result it has become necessary to consider as intimately the geological and historical influences as the ecological and faunistic factors which determine the zoogeographical distribution in any area.

Ekman starts with a discussion of the Tropical Littoral Fauna which shows a marked general homogeneity in the circumtropical region. The tropical fauna is very rich, much richer than that of the colder regions, and is probably the source from which the faunas of the colder seas originated. The detailed treatment of this fauna is prefaced by a general account of the life and the animal associations which are found on coral reefs, and a short discussion of the theories of their origin and distribution. The other important faunistic association of the littorals of the tropics, the Mangrove fauna, is similarly discussed and its characteristics briefly outlined.

The littoral fauna of the tropics is treated under three main heads: (*a*) the Fauna of the Indo-Pacific, (*b*) the Fauna of Tropical West Africa, and (*c*) the Fauna of Tropical America. Of these the fauna of the Indo-Pacific, which is the richest and most diverse, is sub-divided into Malayan, southern central Pacific, Hawaiian, Southern Japanese, Australian, tropic and sub-tropic, and finally that inhabiting the north and western areas of the Indian Ocean. The extent and boundaries of the different areas are discussed and their faunal characteristics enumerated. The littoral fauna of Tropical America which is distributed along the two coasts of Central America in the Atlantic and Pacific Oceans, shows marked similarities, as a result of which in spite of the Panama Land bridge the fauna of this area constitutes a single entity; this is to be explained by an open connection between the Atlantic and Pacific Oceans throughout the Palæozoic and the Mesozoic times and possibly also in the early Tertiaries. The endemic elements and the relationships of this fauna with that of the Indo-West Pacific Fauna are discussed in detail and this is followed by a description of the fauna of the Tropical West Africa on similar lines. Finally it is suggested that the boundaries of the Tropical Littoral Fauna are determined by climatic factors, of which, according to the author, "the temperature is one of the most important zoogeographic factors for the development of the marine fauna".

The past history of this Fauna and its origin are discussed and in this connection reference is made to the Tethys Sea which encircled the globe during the Cambrium and was present with slight changes in its extent and course up to the Middle Tertiaries. As a result of detailed geological studies the conclusions arrived at are as follows:—

(1) During the Cretaceous and early Tertiaries a very rich littoral fauna of the tropical-type was widely distributed in the European Seas. Most of it has become extinct in these parts, to a great extent in the Atlantic Ocean and to some extent all over the world.

(2) The Atlantic Fauna of the early Tertiaries was markedly of the Indo-West Pacific type; this was particularly the case with the Mediterranean Fauna.

(3) The West Indian Fauna during the Eocene and Oligocene periods showed much closer conformity with that of the Indo-West Pacific area than is the case at the present day.

(4) There was in the earlier geological periods a much greater conformity between the faunas of the eastern and western Atlantic. This disappeared to a great extent as a result of the extinction of the majority of the tropical types in the eastern Atlantic Ocean.

The changes in the fauna of this vast area are intimately connected with climatic changes during the Tertiaries. The elevation

of large masses of land in Central America and West Asia coinciding with the adverse climatic changes during Miocene and Pliocene was the determining factor for the later changes in the Tropical Littoral Fauna. From then on was gradually evolved the present-day distribution of the zoogeographical elements resulting in the great contrasts between the Indo-West Pacific fauna and the Atlantic-East Pacific fauna. The development of the faunas took place along new lines from the Middle Tertiaries onwards.

The present-day fauna of the Mediterranean extends into part of the mid-Atlantic along the Moroccan and Mauretanian areas and the Macronesian Islands such as the Canary Islands, Cape Verde, Medeira and Azores, and Ekman designates this region as the Mediterranean-Atlantic. The Mediterranean is evidently a section of the Atlantic, but this does not mean that all its faunistic elements are to be derived from the recent Atlantic fauna. On the other hand, several of its components are the remnants or relics of the Old Tethys Fauna. In addition, since 1869 when the Suez Canal formed an open communication between the Mediterranean and the Red Sea, a large number of erythrean forms have wandered into and established themselves in the Mediterranean.

The Sarmatic fauna which is rightly treated separately by Ekman, deals with the remnants of the inland Sarmatic Sea of the Upper Miocene and later times. Its present-day representatives are the Black Sea, the Sea of Azov and the Caspian Sea. The recent faunistic elements of the Black Sea are, in the main, of Mediterranean origin, but the Sea of Azov and the Caspian have retained more of the older elements. The Tethys fauna, however, does not consist of purely marine forms, but of brackish-water organisms or at least of very euryhaline animals.

The influence of the central Atlantic barrier does not seem to have been very marked in determining the North-Atlantic Littoral Fauna, and the author is, therefore, justified in considering the littoral fauna north of the Bay of Biscay in European waters and the Cape of Hatteras in American waters as a single unit. On practical grounds, however, he deals with the European and American faunas of the areas separately.

The European North Atlantic Fauna is treated under two distinct sub-heads :—(1) The Atlantic Fauna proper, and (2) The Fauna of the Baltic Sea and other brackish-water areas. In either case the hydrographic influences such as temperature, salinity and other factors are discussed and the composition of the fauna from the point of view of its elements such as endemic, northern Mediterranean and northern Arctic, etc., elucidated. In the case of the deeper waters the fauna differs with the substratum, that of the hard sea-bottom being different from that inhabiting a soft muddy bottom. The effects of temperature of the sea waters on reproduction and development resulting in the wider distribution of the animals are also discussed, and according to their reaction to this factor the animals are classed into eurythermic, stenothermic and warm stenothermic forms. The salinity of the waters also plays an important rôle in the reproductive activities of these animals. As examples may be cited the fishes of the family Gadidæ investigated by Damas. The widely distributed north Atlantic forms such as *Gadus morrhua*, *G. æglefinus*, etc., prefer temperatures of 4-6° C., a salinity of 34–35·2 per mille and a depth of 40–200 metres for depositing their eggs. The southern boreal species *G. esmarkii* breeds in 6° C., salinity of 35–35·2 per mille and at depths of 60–200 metres. The Mediterranean-Atlantic and boreal species such as *G. minutus*, *G. luscus* and *G. pollachius*, on the other hand, breed in a temperature of over 10° C., salinity of 32–35·35 per mille and a depth of less than 100 metres. In the Baltic Sea and other brackish-water areas there are, in addition to the pure marine types, a great variety of true estuarine species and several essentially fresh-water animals in the inner regions. The history of the changes in the extent of this area during the past geological ages is discussed, and the influence of periodic glaciations in determining the fauna elucidated. The main relics of the glacial periods are the brackish and fresh-water organisms, the extreme euryhaline species and certain marine and brackish-water animals occurring in isolated brackish-water areas, fjords, etc.

The American North Atlantic Fauna is treated on similar lines, but the information about this area is less complete. The general conclusion arrived at, however, is that the faunas on both sides of the Atlantic Ocean show greater affinity with those of the Arctic and sub-Arctic regions than with that of the intermediate northern and southern areas.

The North Pacific Fauna of the Temperate Zone is found north of Central Japan and along the middle of the southern part of the Californian Peninsula; these form the northern boundary of the Tropic-subtropic Littoral Zone. This Fauna, though it exhibits a certain admixture of tropic-subtropic forms in the southern zone, is entirely different. One finds here a very rich and distinct endemic temperate element with a number of forms of the temperate-Arctic type. The dominance of this Temperate Zone element, which is much more marked on the west coast, is to be explained by the convergence of the isotheres along the western coast, where, as a result, a very marked endemic element of a well-characterised Temperate Fauna predominates. Qualitative and quantitative comparisons of the North Pacific and North Atlantic Fauna bring out the fact that North Pacific Littoral is 6–8 times richer in endemic species than the North Atlantic; the same is the case with endemic genera. The North Pacific is, further, characterized by having endemic families. Reference may also be made here to the discontinuity in distribution of several types in the two areas. The common cod of the Atlantic *Gadus morrhua*, is represented in the Pacific by a nearly allied species *G. macrocephalus*; some ichthyologists, however, consider the Pacific species to be identical with the Atlantic. Similarly the halibut of the Atlantic, *Hippoglossus hippoglossus* is represented in the North Pacific by *H. stenolepis*. Invertebrates show similar discontinuous distributions, and these forms are designated as circumboreal or amphiboreal animals. Their present-day distribution is to be traced to the past times when the species or genera had a continuous distribution throughout the whole regions, but later as a result of climatic changes, the chain was broken and the distribution became discontinuous. Here also glaciation was a very important factor in determining the present-day distribution.

The Arctic fauna is dealt with in great detail and the conclusion arrived at is that the northern hemisphere has mainly two types of faunas, *viz*., a tropical and a northern, and the northern fauna is sub-divided into that of the Temperate Zone and the Arctic region. The faunas of these two sub-zones show very close relationships; in some cases the Arctic appears to be the ancestral type, while in others the Temperate Zone forms must be considered as the parental forms. As a result, Ekman is also of the opinion that both these faunas may have originated from a common ancestor. Two important peculiarities of the Arctic Fauna to which attention may be directed are: (i) along the coasts up to a depth of 4–5 metres the waters, as a result of the very low temperatures, due to the floating ice, harbour remarkably few, if any, animals, and (ii) the correctness of Thienemann's Rule—that whereas the animal communities (Biozonose) of an area (Biotope) become poorer in the species represented with the greater specialization in reference to the conditions determining life in the area, the number of individuals of such species, however, becomes comparatively very much richer, is proved beyond any doubt.

In discussing the fauna of the southern hemisphere below the tropics, Ekman deals with the fauna of the southern Temperate Zone—which is sub-divided into that of (i) South and West African; (ii) South Australian and New Zealand; and (iii) Peru and Southern Chili—separately from that of the colder southern hemisphere. In the latter are included the Kergulean Archipelago, the Antiboreal South American area and the Antarctic Zone.

The fauna of South and West Africa shows very distinct affinities with that of the Indo-West Pacific; but here also there are indications of relationships with the fauna of the Atlantic. The fauna of New Zealand is very closely allied to that of South Australia, and both these show very close relationships with the Indo-West Pacific fauna. The relationships of the fauna of Peru and Southern Chili are not clear, but its relationships with the faunas of the northern area are indicated by the molluscs and crustacea, which have been studied in some detail.

The fauna of the Kergulean Archipelago corresponds to that of the sub-Arctic area of the northern hemisphere, and may, therefore, be designated as the sub-Antarctic fauna. In addition to endemic elements there are types which show distinct affinities with the South American and others with the Antarctic types. The Antiboreal South American fauna shows close relationships with that of the adjacent northern area, but the influence of glaciation makes it rather difficult to elucidate its exact relationships. The Antarctic fauna is, as a result of the isolation of the Antarctic area, particularly rich in

endemic types; the number of such genera, however, is much smaller than that of the species. The isolation of the area, it may be remarked, is not only geographic but climatic as well, and these factors naturally have greatly contributed to the development of endemic types. The relationships of this fauna with that of the Kerguelean and the Antiboreal South America are indicated by the sea-urchins and Ascidians which have been studied by Mortensen and Hartmeyer respectively. A comparison of the Antarctic fauna with that of the Arctic is included in the discussion of the Bipolaritat problem and no further reference to it is necessary here.

The work under review is beautifully produced, with a very large number of excellent illustrations, charts and drawings, and will be indispensable as an authoritative source of reference for marine zoogeographic work. The bibliography at the end of the work is fairly extensive, and the only criticism that may be offered here is that it does not include the very extensive work of the R. I. M. S. "*Investigator*" in the Indian seas mainly published by the Trustees of the Indian Museum and the Zoological Survey of India in a large series of monographs and serial publications.

B. P.

A History of Science and its Relations with Philosophy and Religion. By William Cecil Dampier-Whetham, M.A., F.R.S. (Cambridge University Press, 1935.) Second Edition. Pp. xxi + 514. Price 8*s*. 6*d*. net.

This is a great and scholarly work which it is both a pleasure and a privilege to read. The component parts of the imposing structure of modern science have an evolutionary history, the narration of whose orderly progress amounts practically to recording the struggles of the human mind in its quest of truth. Long before man began to investigate the facts and phenomena of the objective world, he had formulated definite theories and doctrines of his subjective experiences, and for a short time, not long ago, it looked as though they would crumble under the achievements and conclusions of the investigations of the physical and biological sciences. We have in modern times practically returned to the ideas of the old Greeks to whom philosophy and science were one.

Science adopts analytical methods of investigation and mathematical forms of expression of the physical concepts, and these fundamental concepts whether they belong to the realms of the physical or biological science, are now tending to abstractions. The scientific method of approach to the ultimate reality can only reveal certain aspects of it, and philosophers are now recognising that their metaphysical concepts of nature must lack validity when not founded on the evidence of the experimental sciences. The interactions of the different modes of thought naturally reduce the complexities of phenomena to order and simplicity, leading to the discovery of a new realism built up by their means.

We know that civilisation first appeared in the valleys of the great rivers, the Euphrates and the Tigris, the Indus, and the Nile, and knowledge, which must have been crude and empirical at the dawn of history, associated the physical phenomena with the works of beings as capricious as man, but higher in order; and the desire to reproduce those phenomena naturally expressed itself in the practice of strange rites, magic and animistic beliefs. Magic, religion and astrology thus formed the foundations of science. The first attempts to introduce order and rules of measurement were made by the Greek nature-philosophers of Ionia as is evidenced by their efforts to convert the empirical rules for land surveying derived from Egypt into the deductive science of Geometry, the beginnings of which are assigned to Thales of Miletus and Pythagorus of Samos. The nature-philosophers sought reality in matter, and developed the theory of primary element, culminating in the atomism of Leucippus and Democritus. On the other hand the Pythagoreans saw reality in form and numbers, and, later when the Athenian school of Socrates and Plato developed metaphysics, the study of nature was replaced by the study of self, culminating in the development of the theory that ideas alone possessed reality which was denied to the objects of sense. Aristotle returned to observation and experiment at least in biology, but in physics and astronomy he followed the metaphysical doctrines of his master Plato.

During the Roman Empire science ceased to advance, but the Early Fathers of the Church produced a sort of Christian synthesis from their doctrines and those of

Neo-Platonic philosophy and the elements derived from the Oriental Mystery Religions. During the Dark Ages, learning, mainly Greek learning, was confined to the monks, though an Arab school arose, which made contributions to natural knowledge.

In the thirteenth century the scholasticism of St. Thomas Aquinas produced alternative synthesis which, based on the Aristotlian philosophy, gave a new rational scheme of knowledge in which Christian doctrines were blended with Aristotlian science. Scholasticism through the Middle Ages upheld the supremacy of reason, teaching that God and the Universe can be comprehended by the human mind. The way was thus paved for science, which holds that nature is intelligible. The scholastics were the forerunners of modern scientists whose appeal is only to verifiable facts. Scientists do not accept authority as the Scholastics did, but rely on observation and experiment as the ultimate sources of knowledge or as the means of approaching reality. In accepting a system of philosophy on authority, scholastics made full use of reason, examined the logical basis of premises and the validity of deductions in their relation to Christian theology and Aristotlian science. To the scientist observation and experiment are the starting points and final arbiters, and their methods are somewhat like those employed in fitting together pieces or words of a puzzle. To Aquinas and his contemporaries the real world was that disclosed by the senses, and they were unaware of the perplexities of the theory of knowledge and the difficulties underlying the concept of matter in motion by a non-material and non-extended mind which appeared for the first time under the analysis of Galileo.

The work of Galileo was consummated by Newton whose science was converted by his enthusiastic followers into a mechanical philosophy under which man became a machine. The first step to escape from this mechanism was taken by Kant and Hegel who in German idealism derived from Plato, succeeded in separating science from philosophy. This mechanical outlook first promoted by the physical sciences, seemed to extend to the biological sciences when in the second half of the nineteenth century Darwin formulated his Special Theory of Evolution. Man was reduced to a link in the chain of organic development. It became easy for most men of science to hold that physical science revealed the reality of nature and they had little regard for idealist philosophy.

"Physical science represents one analytical aspect of reality; it draws a chart which, as experience shows, enables us to predict and sometimes to control the workings of nature. From time to time great syntheses of knowledge are made. Suddenly bits of the puzzle fit together, different and isolated concepts are brought into harmony by some master mind and mighty visions flash into sight—Newton's Cosmogony, Maxwell's Co-ordination of Light and Electricity or Einstein's reduction of gravity to a common property of space and time. All the signs point to another synthesis, in which relativity, quantum theory and wave-mechanics may fall into the all-embracing unity of some one fundamental concept."

"At such historic moments physical science seems supreme. But the clear insight into its meaning which is given by modern scientific philosophy shows that by its inherent nature and fundamental definitions it is but an abstraction, and that, with all its great and ever-growing power, it can never represent the whole of existence. Science may transcend its own natural sphere and usefully criticise some other modes of contemporary thought and some of the dogmas in which theologians have expressed their beliefs. But to see life steadily and see it whole, we need not only science, but ethics, art and philosophy; we need the apprehension of a sacred mystery, the sense of communion with a Divine Power, that constitute the ultimate basis of religion."

This high note sums up the outlook of this great book, to read which is a liberal and intense education in science and philosophy, and as the reader progresses in his study, his experience and knowledge are exalted into the higher planes of idealism. This is a great book worthy of a great mind.

An Introduction to Astronomy. By Robert H. Baker. (Macmillan & Co., London, 1935.) Pp. 522. Price 15 *sh.*

The book is written to serve as an introduction to Astronomy. The reader is expected to possess very little equipment in the way of previous study intelligently to read the book. The book is written in an attractive style so as to create an interest in the reader for the fascinating subject of Astronomy. Hardly any mathematics is used in the treatment. But this is not always an advantage, for the author in the absence of even simple mathematics cannot but make his account here and there carry little meaning to the reader. An instance in point is the treatment of "Doppler Effect". A short section covering less than half a page is devoted to it. The beginner

cannot appreciate the significance of the following sentence without further elucidation.

"The Doppler effect permits the astronomer to determine how the stars are moving towards or away from the earth, to observe their rotations, pulsations and explosions and to detect closely revolving pairs of stars which the telescope cannot separate."

On the whole we think the author has done well in omitting mathematical treatment in a work intended to be an introduction to Astronomy. The whole book is eminently readable and provides genuine enjoyment. In this connection one is inclined to draw particular attention to Chapter XIII "Within the Milky Way". We have no hesitation in recommending the book to beginners in Astronomy and to all those who wish to have an intelligent understanding of the fundamentals of a subject which no one claiming to be cultured can afford to ignore.

Industrial Electronics. By F. H. Gulliksen and E. H. Vedder, Members A.I.E.E. (John Wiley and Sons, Inc. New York, Chapman & Hall, Ltd., London, 1935.) Pp. xiv + 245. Price 17*sh.* 6*d.*

Many important types of industrial applications in which electronic devices are used, are now being extensively employed. A knowledge of the electronic apparatus and its working is therefore essential to an applied physicist or a practical engineer. The book by F. H. Gulliksen and E. H. Vedder supplies us with such a knowledge. Most of the important electronic devices in industrial technology are very ably and carefully described with an expert knowledge on the subject. Different kinds of tubes, their characteristics and some fundamental circuits are also briefly given before describing the elaborate and sometimes complicated circuits employed in commercial electronic instruments and control equipments and their applications which form the subject-matter of this very useful book. The type of equipments primarily used for wireless communication purposes, *viz.*, modulation, detection and amplification of high-frequency signals, is, however, left outside the scope of the book. A very brief outline of the methods generally employed for such wireless communication purposes would have been very useful.

The book is divided into four parts. The first two parts are of an elementary nature and give more or less up-to-date information about the different kinds of electronic tubes and some fundamental circuits associated with them. In Part I the authors have classified the electronic tubes into three general classes. The first class is light-sensitive, the second high-vacuum and the third gaseous. A brief description of the three classes of tubes is given with the specific object of illustrating their working in different applications. The chapter on gas-filled tubes is comprehensive. Besides the rectifying tubes, it deals with some representative grid-controlled and ignite-actuated tubes. In Part II some fundamental circuits for high-vacuum amplifiers (low-frequency) and for grid-controlled gas-filled tubes and ignitrons are shown. With regard to high-vacuum amplifiers, the different methods of multi-stage low-frequency amplification are briefly given. The triode as an oscillator is very inadequately dealt with—although the circuits given for ordinary oscillating tubes and the multi-vibrator will be of practical value. The control circuits for grid-controlled gaseous discharge tubes and for the ignitrons will also be found very useful. While setting out the circuit diagrams, it appears the authors have assumed a knowledge of the fundamental physical principles on the part of the readers. A brief exposition of these principles in the first two parts, however, would have greatly facilitated the understanding of the last two parts—especially for the beginners who want to gain a working knowledge on the subject. The lack of proper emphasis on the physical principles is, in fact, a criticism which applies more or less to the whole of the book. It is needless to say that the fundamental principles clearly set out, not only help the understanding of the practical working but also give a broad and comprehensive view of the subject. It is hoped the authors will include in the next edition a short and clear exposition of the Physics of the subject, especially in Parts I and II which are regarded as a prelude to the remaining two parts.

Part III is devoted to commercial electronic instruments and control equipments and their applications. Among the light-sensitive control devices, photo-electric relays and their applications, elevator floor levelling, elevator door safety control, automatic control for artificial lighting, Louvre controller, door controller, sorting, grading and

matching will be found very interesting and useful. Only such details are given as are necessary for the understanding of the actual working of the appliances. Among the Indicating and Recording devices, the most important instrument described is the cathode-ray oscillograph which covers a wider field of applications than the mechanical oscillographs, for it can be used for the study of electric phenomena at radio-frequency, whereas the mechanical oscillographs are limited to about 10,000 cycles. The description of the working of the cathode-ray oscillograph, however, is not complete, since the authors have kept the subject of radio-frequency outside the scope of their book. Some useful and practical circuit-diagrams are given for the oscillograph work. Such useful recording devices as Smoke Indicator, Transmittency Instrument, Colour Matcher, Telemetering, etc., are explained with diagrams. The chapter on Rectification and frequency conversion deserves special commendation. It deals with rectifiers for low power and low voltage, mercury-arc rectifiers, ignitron-rectifiers and electronic inverters. The diagrams of circuits and of wave shapes of rectifier voltages and currents are shown. The fundamental relations between transformer voltage and output voltage for single-phase, three-phase and double three-phase circuits for ideal conditions with a resistance load have been clearly indicated so as to give a conception of the factors involved in the circuits. Circuit diagrams for electronic inverters have been clearly set out. Industrial applications of these electronic inverters, there will be many in future when there will be a considerable reduction in the price of the tubes. The chapters on the Control of Resistance Welders and Theatre and Mobile Lighting control will be of interest and help to those electrical technicians who work along these lines. Under miscellaneous applications, Oil Burner control, Train control and Cab Signalling, Resistance and Contact control devices in many industrial concerns are discussed. Precipitation rectifiers and Industrial X-ray equipment are also dealt with.

The chapter on Electronic Relays will be very much appreciated. We find in it the most modern applications of the Electronic relay equipments. Electromagnetic types of relays will soon be replaced by these electronic relays which are characterised by low consumption of control energy, quick response action, absence of contacts and moving parts and flexibility in circuit design and adjustments. All the sections in this chapter, *viz.*, Automatic synchronisers, Time-Relays, Cycle-Splitters and protective relays, show evidence of first-hand knowledge of the modern electronic equipments.

Part IV deals with Electronic Regulators. The automatic regulators are generally of the electromagnetic type. The introduction of the electronic regulators has extended the possibility of regulator applications especially in the industrial field. After setting out the fundamental principles of automatic regulator design, the authors describe the following chapter by chapter:

Voltage Regulators,
Speed Regulators,
Photo-electric Register Regulators,
Calorimetric Regulators,
Temperature Regulators.

All the chapters are full of useful, up-to-date and practical informations based on expert technical knowledge of the subjects.

Recent developments in Industrial Electronics are to be found scattered in different scientific and technical journals. Gulliksen and Vedder's book will be a very useful compendium of all the important modern developments. References to original papers appended at the end of each chapter add considerably to the value of the book. Insufficiency of details or vagueness at times due to the brevity of treatment has been amply compensated by these references.

To the applied physicists and electrical engineers the book will be of immense practical value.

S. R. KHASTGIR.

Experimental and Theoretical Electrochemistry. By M. Dole. (McGraw-Hill, London, 1935.) Pp. 549. Price 30*s.* net.

In its widest sense Electrochemistry includes all chemical phenomena, since there is probably no form of chemical energy which is not essentially electrical in origin and no chemical phenomena of which the origin cannot be traced to an electrical effect. Dr. Dole, however, limits electrochemistry to chemical knowledge which has been obtained by experiments involving the application of electric or magnetic fields. This definition emphasises the experimental side of electrochemistry and indeed this book has definitely an experimental bias.

Some of the subjects included in older books such as the theories of indicators, of neutralisation, and of buffer solutions have been omitted; from the author's point of view they are outside the domain of electrochemistry. But their place is well taken by discussions of such interesting and important subjects as dipole moments, molecular rays, high frequency and high voltage conductance, electrokinetic and electrocapillary phenomena, and phase boundary and semipermeable membrane potentials. A good deal of space, as is natural, is devoted to conductance of electrolytes. The discussion on concentration cells is adequate and, from the student's point of view, is greatly improved by the inclusion of a chapter in which the fundamentals of thermodynamics are clearly outlined. The chapter on the glass electrode is a valuable addition, as this new type of hydrogen electrode has not been adequately treated in older text-books.

The book is well and clearly written, there are a sufficient number of references to the original literature to guide the student in the extension of his reading, the diagrams are clear and illustrative and the proof reading has been carefully done. The author is to be congratulated on having produced a text suitable in every way for use by Honours degree students.

T. S. W.

Probability and Random Errors. By W. N. Bond, M.A., D.Sc., F.Inst.P. (Messrs. Edward Arnold & Co., London, 1935.) Pp. 141. Price 10*s.* 6*d.* net.

One of the most useful and potent tools of laboratory practice, to-day, is a knowledge of Probability and Random Errors. Experiments may be planned and carried out, results may be obtained and interpreted, and conclusions arrived at; but unless the reliability of the results is ascertained, the conclusions may remain in a state of doubt. Attempts to confirm the results, by repetition of the experiments may be made, where they are really not required, and no such attempts made at all, where they are required to be made. In such cases, and in many others, in social, biological and physical sciences, the application of Probability and Random Errors is very essential.

As the author himself points out in his introduction to the book, it is as important to state the probable degree of accuracy of results as it is to state what is measured and the units in which the results are measured. A knowledge of this branch of mathematics is therefore very useful to the student of any branch of science. A number of books on the subject, which require a considerable knowledge of mathematics on the part of the student, are available. But, for a student specialising in any particular branch of science, a book like the present one with a non-mathematical treatment of the subject-matter is very welcome indeed. The author has done great service to science by providing this useful book for the use of research workers. Though the book is mainly meant for the use of students of physics and chemistry, students of other branches of science could also use the book with great advantage. The subject is dealt with in a simple and understandable manner; with a working knowledge of mathematics, the matter dealt with in the book can be followed and understood. The large number of worked examples given in the book add to its usefulness to the student.

Analytical Chemistry. Vol. II. Quantitative Analysis. By F. P. Treadwell and William T. Hall. (Chapman & Hall, London, 1935.) Pp. 858. Price 30*s.*

So familiar and so useful is Treadwell and Hall's *Analytical Chemistry* (both qualitative and quantitative) to the student that it is hardly necessary to dwell on its merits. This brief review will serve no more than as an announcement to the appearance of the eighth edition of the second volume,—quantitative analysis. The book has been entirely reset and brought up-to-date. New and well tested methods have been described for the estimation of columbium, tantalum and certain other metals and much useful recasting has been done to improve the work.

It is difficult to review a book of this type. The best test of the excellence of a book is its popularity and judged by this standard, there is no doubt that the book occupies a pre-eminent place in the analysts' library. It would be ungrateful to try to point out any errors in a book of this importance but one is tempted, however, to mention that on page 78 under Gunning's method for determining nitrogen, it is mentioned that potassium sulphate is used as a catalyst

in the place of mercuric oxide originally recommended by Kjeldahl. This is not so; potassium sulphate serves to raise the boiling point of sulphuric acid and the digestion proceeds much faster than when sulphuric acid alone is used; a catalyser is still necessary and a small quantity of $CuSO_4$ or mercury or manganese dioxide is generally added. On page 77 under the procedure for Kjeldahl's method for determining nitrogen, it is mentioned that "2–30 ml. of concentrated sulphuric acid" should be added to a weighed quantity of the substance in the digestion flask. This is obviously a printer's error for 20–30 ml. No one will recommend the addition of 2 ml. to 0·7–3·5 gm. of substance in a 500–600 ml. Kjeldahl flask!! These errors are very minor indeed.

The binding and general get-up of this enlarged and revised edition are in the familiar style and are of the usual excellence.

Die Forstbenutzung (Forest Utilisation). A Text-Book and Hand-Book founded by Dr. Karl Gayer, Professor in the University of Munich. Thirteenth Edition (in the German Language) rewritten by Dr. Ludwig Fabricius, Professor of Sylviculture and Forest Utilisation in the University of Munich. (Berlin, Paul Parcy.) Pp. 758. 8 vo., with 448 illustrations in Text and two colour plates. Price in India 25·50 Gold Marks.

The fact that Dr. Gayer's *Die Forstbenutzung* was first published in 1863 and now appears in its thirteenth edition is eloquent testimony to its continued usefulness. During the period of nearly three-quarters of a century since its first publication, the practice of Forest Utilisation has undergone many and occasionally revolutionary changes. "Minor Forest Produce" have assumed increasing importance. The different editions of Dr. Gayer's work have faithfully covered all these changes. The book has been fortunate in its Editors who have kept up the high standard of the original in being at once thorough and up-to-date. In a very special sense, therefore, these editions mark definite steps in the theory and practice of German Forest Utilisation. The book under review, appearing after an interval of 15 years (the twelfth edition appeared in 1921) is a worthy successor to a very distinguished heritage.

Prof. Fabricius has not altered the general plan of the book. "Wood" being by far the most important Forest Produce has occupied the Part I of the volume. The requirements of the Wood Cutter and the wood working implements have been clearly described, after which are given the methods of felling and storage of wood. This is followed by detailed accounts of the conversion of wood into finished and semi-finished products in saw-mills, workshops, cellulose-, paper- and artificial silk factories, in wood-gas plants and what is perhaps most interesting, in wood sugar plants.

Part II of the book, is devoted to Minor Forest Produce and deals with such varied products as Bark and Vegetable tannins, resins, fruits, fodder, litter, peat and other forest produce. The author has throughout kept before his reader the fundamental maxim that in Forest Utilisation—as in any other sound commercial enterprise—the capital must never be allowed to depreciate.

It is characteristic of German thoroughness that forest utilisation is also considered in relation to national economy. When times are so unsettled politically and when the desire, for national self-sufficiency is degenerating to an insane craze, the intelligent utilisation of forests may prove vital to the very national existence. This is the justification for the inclusion in the book of such modes of utilisation as Wood carbonisation, Resin tapping, etc., which although obsolete in Germany at present, may leap into prominence during an emergent period of stress.

The exposition in the book is very clear. No one who has had the privilege of hearing the Professor's lectures would expect anything else. The gift of the true teacher—that of putting himself in the student's place—is manifest throughout the book. This enhances the value of the volume as a "Text-Book." The carefully analysed description of contents at the beginning and the elaborate index (there are some 2000 guide words) at the end of the volume justify its sub-title—A Text-Book and Hand-Book.

Prof. Fabricius' *Forstbenutzung* is a fine example of German Scholarship at its best. It would be sad if the language difficulty should render it inaccessible to Indian foresters. Such books make one sigh for an Esperanto that would sweep away the clumsy barriers of mere language.

EMMENNAR.

for every point) of $f(z)$ were equal. Now Menchoff has proved by a very intricate analysis that we can have this broader criterion, *viz.*, the derivates in any two directions at almost all points (the directions not necessarily the same for every point) in the region are to be equal. Perhaps, it is interesting to remark that although analyticity can be stated in a form not involving the idea of an integral still there is no proof of this classic result without the *via media* of Cauchy's theorem. It is any way a mystery.

K. V. I.

A New Method for the Study of the Stark Effect.

As is well known there are two methods for the study of the Stark effect, *viz.*, that due to Stark himself and the Lo Surdo method. In the former molecular spectra cannot usually be excited and even atomic spectra are weak in intensity. In the latter there is the advantage that only one source of current is used and high intensity of the spectra is obtained, but because of the inhomogeneous field employed, the measurement of the field is difficult and an astigmatic spectral apparatus like the Rowland concave grating can be used only under limitations. W. Steubing and T. A. Shaeder (*Ann. d. Phys.*, 1936, **25**, p. 97) have designed an apparatus in which great intensity is reached both in atomic and molecular spectra and in which the field strength can be accurately measured. The principle made use of is that by employing a *hollow cathode* closed on the side opposite to the anode by a sieve, the arrangement of Stark can be employed without undue heating of the anode at even high pressures. The intensity of the light excited between the cathode and an auxiliary electrode employed to produce the required electric field depends on the size of the holes in the sieve so that the correct size of holes for the maximum light intensity has to be determined. Filter pumps, mercury pumps and two stage diffusion pumps were used in combination and the pressure was measured by means of a McLeod gauge. The gas to be investigated was let into the apparatus through a needle valve and sucked out by the pumps. The main discharge was produced by two generators each giving two kilovolts and the current employed was 90 mA. The applied voltage was from 3 to 3·5 kv. while the fall of potential within the discharge was 300 to 800 volts. In order to keep the field between the cathode and the auxiliary electrode constant when the current in the discharge varies a special stabiliser was employed. The anode was cooled with water. Special arrangements were made to prevent a discharge taking place between the cathode and the auxiliary field-electrode. The construction of quartz, glass and metal discharge tubes is described in detail in the paper. The experimental results in the case of H, He (atomic), H_2, N_2 and O_2 (molecular) spectra are given. Thus the investigation of the Stark effect of molecular spectra has been rendered easy by the construction of this new type of apparatus and it represents a considerable advance in the technique of Stark effect measurements.

T. S. S.

A New Method for Obtaining Perfectly Polished Metal Surfaces.

THE ordinary method of polishing metal surfaces with emery paper of graded fineness leads to unevenness and under the microscope even the best polished surfaces show scratches. Now P. Jacquet (*Comptes Rendus*, 1935, 201, 1473) gives an electrolytic method of polishing which gives a surface free from any scratches. Photographs given by the author show that the surface appears smooth even under a magnification of 1200. The process adopted is as follows: The metal to be polished is made the anode and immersed in an aqueous solution of ortho- or pyro-phosphoric acid containing at least 400 grams of the acid per litre and maintained at a temperature between 15° and 25° C. The cathode is a copper plate of greater area than the anode. The potential difference between the ends of the cell is measured by means of a sensitive voltmeter and an ammeter and rheostat are included in the circuit. As the resistance is gradually decreased, the voltage between the ends of the cell increases at first while the current density remains constant, then the current density increases rapidly with increasing voltage up to a certain value but afterwards diminishes while the voltage is still increasing. We next come to a stage when the current density remains constant while the voltage rises from a value V_1 to V_2. If the resistance is further decreased the current density increases rapidly with increase in voltage and bubbles of gas are given off in greater and greater abundance. If the voltage is kept somewhat below V_2 so that no bubbles are formed, the metal surface becomes finely polished. If V_2 is exceeded the surface

becomes spotted and so care should be taken to keep the voltage below V_2, say at 1900 volts if gas bubbles are given out at 2100 volts. The current density corresponding to this voltage depends on the concentration of the solution and on the position of the anode. Thus with a solution containing 530 grams of H_3PO_4 per litre, one surface of a copper plate anode whose other face is protected by varnish becomes polished with a current density of 10 ampères per square decimetre if kept vertical, while if it is horizontal and below the cathode, a current density of 6 ampères / dm.^{2} suffices. Besides keeping the voltage below V_2, filtered solutions should be used and any gas bubbles forming on the plate when it is immersed in the solution must be avoided. In this way a plate of copper which, when polished with emery paper No. 05, showed bad scratches under a magnification of 1000, showed a perfectly smooth surface even under a magnification of 1200 when it had undergone the above treatment for 15 minutes.

Shape of String-like Amphoteric Ions in Solution.

THE dielectric constant of a solution of amphoteric ions increases with the concentration according to the law $\frac{d\,D}{d\,c} = k\,z$ where z is the number of chain units between the NH_2 and COOH groups. It could be shown from the expression for the orientation polarisation of such solutions, on certain assumptions, that μ the dipole moment of the ions must be proportional to $\sqrt{z}$, and not to z, as would be expected for a regularly increasing straight zig-zag chain length. Such a proportionality law is, however, in agreement with the statistical calculations of the shape of long chain hydrocarbon molecules carried out by Kuhn (*Koll. Z.*, 1934, **68**, 2). Kuhn has now extended these calculations for the actual case of amphoteric ions where there is an attraction between the oppositely charged ends (*Z. physikal chem.* (A), 1935, **175**, 1), and finds that while the value of r^2 the average of the square of the distance between the two ends is different, the proportionality law $r^2 \sim z$ remains unaffected. Incidentally it is found that the inner field must be weak in these solutions on account of the solvent molecules interposed between the ends of the chain.

M. A. G. RAU.

Formation of Molecular Clusters in Liquids.

WHEN light polarised in the vertical direction or Z-axis is incident on a medium, the light scattered at right angles is essentially a mixture of linearly polarised light and some natural light. This depolarisation is due, as is well known, to the occurrence of anisotropies along with density fluctuations in the volume element of the liquid medium. That the scattered light is a mixture of the natural with the linearly polarised light is also demonstrated by the fact that when the incident light is polarised along a horizontal or the Y-axis, the scattered light is pure natural light with equal polarisations along the X and Z axes. The depolarisation factor is 1. Recently R. S Krishnan has observed (*Proc. Ind. Acad. Sciences*) that when the last experiment is carried out on a liquid mixture which shows a critical solution temperature, then over a range of temperatures above this, the scattered light contains in addition to the natural light some linearly polarised light also. The depolarisation is thus <1. This phenomenon has been rightly attributed by him to the presence of large clusters of molecules in the medium. Prof. R. Gans has now analytically examined the shape and size of such clusters (*Physikal Zeit.*, 1936, **37**, 19) and shown that the clusters must be non-spherical in shape in order that, what he calls, the Krishnan effect, may be observed.

M. A. G. RAU.

The Structure of Hydrous Oxide Sols and Gels.

THE constitution of Sols and Gels in general and of the hydrous oxides in particular is a subject of a great deal of interest, though there is still difference ot opinion amongst workers in this field. Weiser and Milligan have tackled this problem from various points of view in a recent paper (*Trans. Far. Soc.*, 1936, **37**, 358). Regarding the constitution of gels of ferric oxide, alumina and stannic acid, they have shown by Phase rule studies of the dehydration process as also by X-ray diffraction methods, that the gelatinous oxides are not polymerised bodies or products resulting from the loss of water from hypothetical metallic hydroxides. The view put forward by Willstätter and others that a part of the water in the gel is chemically combined and a part as being adsorbed has not been found to be tenable. The X-ray methods have revealed that during the ageing of the gel of ferric oxide, there is a gradual agglomeration of extremely minute

crystals of the oxide which hold large amounts of water by adsorption or capillary forces. In the case of alumina gels, there is evidence for the formation of a single hydrate, *i.e.*, $\gamma\ Al_2O_3 . H_2O$. The constitution of the α and β stannic acids has also been settled by X-ray analysis, and it is found that the difference in their properties is due to the size and extent of the aggregates.

The structure of the micelle in hydrous oxide sols is also of considerable importance. The existence of basic salts of definite composition in sols has been seriously questioned. Pauli has suggested the formation of complex colloidal ions, while Thomas and his co-workers have formulated Weiner complexes in the micelle. These assumptions are rendered highly improbable by X-ray studies. Potentiometric analysis has also been employed for the study of the structure of interfaces in aqueous colloids. The micelle of the hydrous oxide sols are aggregates of crystals of the oxide with anions adsorbed on the surface. It has however been pointed out by K. H. Meyer that the term adsorption is referred only to the places where ions or molecules are held up, and not to the nature of the forces responsible for such linkages, which may be Dipole forces, electrostatic attraction or homopolar binding.

M. P. V.

Soy Bean Oil as Core Oil.

OIL bonded cores are much in evidence in America, where the sand used is rather coarse, necessitating the use of some bonding material such as commercial linseed oil, Japan drier and kerosene. The suitability of Soy Bean oil, by itself and when mixed with different proportions of linseed oil, Japan drier and kerosene, has been the subject of investigation at the Engineering Experiment Station of the University of Illinois in the department of Mechanical Engineering. The results have been published in the *University Bulletin* (*No.* 235, 29, No. 11, dated October 6, 1931), by Carl H. Casberg and Carl E. Schubert. Several kinds of Soy Bean oil were tested by the standard methods adopted by the American Foundrymen's Association. It was found that the tensile strength of cores tested bore a certain definite relation to the iodine numbers of Soy Bean oil and kerosene, the ratio being

$$\frac{\text{Tensile strength}}{\text{Iodine Number}} = 1 \cdot 0161.$$

Tensile tests were made on cores (1) with raw Soy Bean oil, (2) with Soy Bean oil and kerosene, (3) with raw Soy Bean oil, kerosene and Japan drier, (4) with raw Soy Bean oil and linseed oil, and (5) with raw Soy Bean oil, linseed oil and kerosene, made of core sand of A.F.A. specification class No. 4. In each case it was observed that the tensile strength was maximum when the cores were baked for not more than one hour, the percentage of raw Soy Bean oil to Japan drier being 85 : 15 for optimum conditions. The main conclusion arrived at was that raw Soy Bean oil was suitable as a core oil, provided that the cores were baked for required times (one hour in most cases) depending on the fact whether it was used by itself, or mixed with linseed oil or with different proportions of kerosene or kerosene and Japan drier.

K. B. K. R.

The Sugar Industry in India and the Borer Pest of Sugarcane.

IN a well-reasoned statement supported by facts and figures, Noel Deerr (*Agriculture and Live-Stock in India*, Vol. 5, Pt. III) draws attention to the serious menace of the sugarcane borer pest in Upper India and pleads for strong and prompt measures being taken to control the pest. As the result of a survey of typical areas he states that the crop in Upper India is heavily infested and that associated with the borer injury is also the loss of sugar in the cane due to the entry of micro-organisms into the cane through the door of the wound injury. Even in an exceptionally fine crop the loss to the grower is put down as 8 per cent. The average of eight surveys brings out the loss to the miller as 800 maunds of sugar per 100,000 maunds of cane crushed and that, if calculated for the industry in the whole of India, this works out to a loss of one crore and thirty-three and a half lakhs of rupees. To this is to be added the corresponding loss to the Excise revenue of the State which will amount to 12 lakhs of rupees annually. The same and perhaps more may be said of the sugarcane being grown for the factory in Mandya. A strong plea is put forward for starting control measures by means of the parasites of the cane borer which have been found about the only satisfactory method elsewhere and to the success of which in the Hawaii he bears

personal testimony. He would suggest the expenditure on such a campaign being met as a legitimate charge on the Sugar Excise revenue now being collected. In Mysore a beginning has already been made on this very method of biological control which, however, has to be carried on on a very much more extended scale than at present if it is to make any impression at all in arresting the pest.

A. K. Y.

The Burning of Forest Pastures.

THE reasons underlying the ancient practice of setting fire to hill side and forest grass land after the season's growth is over which, though strongly condemned from the point of view of forest conservation, is persisted in the belief that it improves the pasture value of the land, are examined in the course of an extended study of the matter and some very interesting and suggestive conclusions drawn by S. W. Greene of the U. S. A. Bureau of Animal Industry (*Journal of Agricultural Research*, **50**, 10). We can only extract parts of the summary of the conclusions and would commend a perusal of the full paper itself to interested readers as some of the data point to the need for a revision or at least a re-examination of current views on important aspects of agricultural practices.

Analyses of soils taken after 8 years of annual grass burning as compared with complete fire protection showed 1·6 times as much organic matter in the burned over soils as in the protected soils. The former also contained 1·5 times as much nitrogen as the protected soils. The greater quantities of organic matter and nitrogen apparently result from roots rather than from the above ground portions of the plants. Whether the plant debris was burned in place on top of the soil or was left to rot apparently had no direct effect on the content of organic matter or of nitrogen. In both cases organic matter and nitrogen above ground was largely lost to the soil, the increases thereof being influenced only by the amount and composition of decaying plant roots. Grass and legume growth on the areas showed that the forage growth on the burned areas was more than double that on the unburned areas after a period of 8-9 years of experiment. The increased amount of nitrogen in the burned areas is attributed to the increased growth of native legumes, their ability to take nitrogen from the air and the additional growth of other plants which take up soluble forms of nitrogen and prevent them from being leached out. The increase in organic matter and nitrogen on the burned areas was also reflected in the higher crude-protein content of the principal forage grasses on this area and in the increased number of soil micro-organisms. The accumulation of plant debris on the top of the soil did not materially increase the soil moisture in spite of the fact that much larger quantities of water were required to support the extra forage growth on the burned over areas. Organic matter on top of the soil absorbs a portion of the rainfall which is thus prevented from reaching the soil for the use of growing plants.

The experiment was conducted on a tract of 320 acres of virgin forest land in southern Mississipi, U. S. A.

A. K. Y.

Pyosepticæmia of Calves.

IN the Punjab from figures collected over a period of five years, cases of Pyosepticæmia of calves are noticed to occur commonly and in a serious form on certain farms periodically, affecting chiefly calves over 10 days and under four months old, about 35 per cent. of cases proving fatal (Shirlaw, *Indian J. Vet. Sci. and Animal Husb.*, 1935, **5**, 232). Adults also are seen affected sometimes. The disease is septicæmic in young animals and pulmonary of a special type in old animals. An organism of the *Salmonella enteritidis* group is stated to be the cause in the Punjab as it was discovered from a majority of the cases there. Specific agglutinins against this organism were observed in the sera of diseased calves and their mothers. Direct contact and feeding on cultures fail to transmit the disease to healthy calves. Subcutaneous and intravenous inoculation of cultures produce the disease in indigenous calves.

S. D. A.

Bovine Nasal Schistosomiasis.

THE length frequency curves of the ova of *S. nasalis* and *S. spindalis* provide additional proof that these two worms are different (Anantha Narayana Rao, *Indian J. Vet. Sci. and Anim. Husb.*, 1935, **5**, 266). No abnormal shapes of ova of *S. nasalis* could be detected in mature ova examined. The previous experiments of artificial infestation

with *Cercariæ indicæ* XXX Sweell, 1922, to produce nasal schistosomiasis are confirmed. The buffalo and some bovines appear to have a partial immunity conferred by *S. spindalis* against a later infestation with *S. nasalis*. The presence of what looked like ova of *S. nasalis* in a growth from the base of horn of a bullock is recorded. Susceptibility of sheep to nasal schistosomiasis appears to be doubtful.

Spermatogenesis of Stenophylax.

A BRIEF account of Stenophylax spermatogenesis has been given by R. A. R. Gresson (*Quart. Journ. Micro. Sci.*, Vol. 78, No. 310, Dec. 1935). The nucleus of the spermatocyte is seen not to take any important part in the formation of the chromosomes and persists as a distinct body till the end of prophase when it is probably cast out. The diploid chromosome number is sixty. The Golgi material which is at first in the form of a single mass divides into two parts just before division, which become distributed between the two daughter cells. The mitochondria are granular and during division arrange themselves on the sides of the spindle and so get distributed between the daughter cells. The Golgi body is probably responsible for the acrosome but the main part of the former becomes fragmented and enters the tail of the sperm. The mitochondria are filamentous in the spermatid and invest the axial filament in the form of a close sheath. A peculiar clear vesicle is seen to arise in the spermatid nucleus: its significance is unknown and it disappears later.

The Vascular System of *Octochætus thomasi*.

A DETAILED account of the vascular system of any acanthodriline earthworm is not described anywhere and therefore M. Bleakly's paper on *O. thomasi* (*Quart. Journ. Micr. Sci.*, 1935, **78**, Part II), is of considerable interest. The dorsal vessel is double posteriorly to the gizzard, being connected with each other by commissural vessels anterior to each septum. There are six pairs of lateral hearts occupying segments 8 to 13. The dorsal vessel supplies blood to the lateral hearts and also to the ventral vessel. The latter is the main arterial trunk and the flow of blood is backward posterior to the hearts. The dorso-intestinals and dorsotegumentaries debouch their blood into the contractile dorsal vessel. The dorsal vessel is arterial in nature anterior to the hearts while posteriorly it is venous. No subneural vessel is present.

Radioactivity and Geothermal Gradients.

IN a paper read before the Royal Society of Canada, Justin De Lury and H. C. Lane (*Pan-American Geologist*, **64**, No. 2) have shown the intimate relation that exists between radioactivity and thermal gradients. From the data compiled by different workers, it is believed that granite is two to three times richer in radioactive elements than basalt, and four to five times richer than peridotite. The radioactive elements are largely concentrated on the surface and their distribution is by no means uniform. These radioactive elements are considered to be the important source of heat, specially at shallow depths. The observed variations in thermal gradient are due to the varying distribution and concentration of the radioactive elements. According to the authors the important factor governing the thermal history of the Earth, is the migration of the radioactively rich materials "both horizontally and vertically" due to the erosion and movements of the magma.

Schiller Structure.

SINCE the time of Werner, the word "Schiller" has been used to express a particular type of sheen structure noticed in minerals. But later some authors have extended the term to include the iridescence noticed even in certain of the felspars, amphiboles and pyroxenes. In reviewing the usage of the term "Schillerisation" in Geological terminology R. J. Colony (*American Mineralogist*, **20**, No. 12) has shown that the term schiller structure is a misnomer, because there is no single specific structure responsible for the effect, since it is dependent not upon the kind of the inclusion but upon its size and thinness. Hence a suggestion is made by the author that the term schiller be restricted to iridescence displayed by minerals where the "sheen is caused by reflection of the light from either inclusions or planes". For all other types of minute inclusions the author suggests the use of the term "Endoblastic".

Nappe Structure in the Archæan Rocks.

FROM an intensive study of the structure shown by the Archæan rocks around Deolapar, in the Ramtek tahsil of the

Nagpur District (forming part of the well-known Sausar series of Dr. Fermor) Mr. W. D. West (*Trans. Nat. Inst. Sci., India*, I, No. 6, pp. 93-102) has put forward some evidence to show that in this area, the folding of the rocks reached the highest degree possible, and that a large body of rock, covering many square miles, was forced horizontally over a considerable distance, the *Nappe* thus produced coming to rest discordantly upon another portion of the same series of rocks. After giving a detailed account of the geology of this area, Mr. West has followed two main lines of argument, in support of his inferring a *Nappe* structure. One argument is based on the fact that a definite plane of discordance in the succession of rocks has been determined of such a nature as to suggest horizontal rather than vertical movement. The other argument is based on the sudden change in the lithology of the Bichua stage, so strikingly seen just east of Deolapar, which suggests that the two outcrops of the Bichua stage found here were not originally deposited as close together as they are now found.

While it is true that the evidence for a *Nappe* structure in this area is not by any means indisputable, it is obviously difficult to offer any other explanation of the facts mentioned in the paper; and though the conclusion reached by Mr. West has been based on the study of a comparatively small area, there is no doubt that the recognition of the existence of the *Nappe* structure in the Archæan rocks, involving the horizontal displacement of large rock masses, will help to explain some of the metamorphic anomalies and difficulties of correlation which are so puzzling in these very ancient rocks.

Attrition Tests on Stone used as Road Metal in India.

DR. M. S. KRISHNAN in an interesting paper (*Rec. Geol. Sur. India*, 1935, **69**, Pt. 3, 361–383), has given an account of the tests on road-making stones carried on for about a decade past in the Engineering section of the Government Test House at Alipore, Calcutta. After outlining briefly the method of experimentation, the results of tests carried on a very large number of samples covering a variety of Indian rocks, have been arranged suitably in tabular form. A discussion of the test results has also been included and Dr. Krishnan states, "the best stones for road-making purposes are the medium to fine-grained, compact, basic rocks like dolerite, basalts and epidiorites. The coarser grained rocks, acid types and compact gneisses come next. Granulites and hornfelses also occupy a high place amidst road-stones. The markedly porphyritic rocks are liable to be crushed under load. The soft rocks like the limestones, shales, laterites and the weaker types of sandstones are not suitable for any but light traffic, while vein quartz and quartzite (except perhaps some highly ferruginous types) are generally to be avoided."

M. B. R.

Industrial Outlook.

Modern Sewage Pumping*: The Latest Scientific Principles.

DURING recent years great advances have been made in the pumping of sewage and a good example is the extensive additions and alterations that have recently been carried out in England at the Reading Corporation sewage works, Manor Farm (Berks).

In general the additions comprise two new concrete pre-sedimentation tanks, each 160′ 0″ × 52′ 6″ with a depth of 8′ 0″, together with all the necessary mains and connections. Also there are three new pump houses, nine new sludge drying beds having a total area of about five acres, six large solid digestion tanks with a total capacity of over 3,000,000 gallons, new filters with an area of approximately two acres, and a depth of 10′ 0″, and six new concrete humus tanks each 100′ 0″ × 50′ 0″.

Much other accessory plant and equipment is included, as well as two 24″ diameter concrete mains having a total length of about two-thirds of a mile, which connect the filters to the main works. Operations were commenced in May 1934 and the scheme has now just been completed.

* Contributed by David Brownlie, 46, Grange Road, Ealing, London, W. 5.

The pumping plant is being supplied by the Pulsometer Engineering Co., Ltd., Reading, and the full equipment, operating in the three pump houses, includes six "Stereophagus" pumps and one "A. V. 4." and one "F.W.4. (Fullway)" centrifugal pump, all direct driven by slip ring A/C motors (3-phase, 50 cycles, 220 volts). Two of the "Stereophagus" pumps are 5″ diameter with horizontal drive, each with a capacity of 475 gallons per minute of unscreened sewage, while another of the pumps, 5″ diameter with horizontal drive, has a duty of 300 gallons of crude sludge per minute.

Also two of the "Stereophagus" pumps are of the vertical drive type, one being a 6″ unit with a duty of 550/650 gallons per minute for the main sludge, and the other 4″ diameter, operating the sludge return with a duty of 200 gallons per minute. Finally there is a 4″ horizontal pump of this type with a duty of 260 gallons per minute of effluent. As regards the "A.V." 4″ centrifugal pump this also has a horizontal drive and takes the top water and the humus, with a duty of 317 gallons per minute.

Essentially the "Stereophagus", it will be remembered, is a modified form of centrifugal pump with a conical impeller and a special internal cutting knife of hardened steel so that it can deal with unscreened sewage cutting up the solid matter in suspension to a size which facilitates subsequent handling. The impeller revolves in a volute casing and in normal running the liquid is passed by the impeller alone and the knife which is fixed parallel to the face of the impeller vanes, does not come into action until some solid material enters which is too large to pass between the vanes. When this happens it is immediately cut by the scissor-like action given by the stationary knife and the moving plates, the solid passing the knife again and again until sufficiently small to pass through.

Further with regard to the Reading Corporation it may be stated that two "Stereophagus" installations of this kind are already operating, one at the Whitely Road pumping station, consisting of two 5″ horizontal spindle pumps, each of 355/465 gallons per minute capacity, and the other at the Kidmore End pumping station, which has two 3″ vertical spindle pumps, each of 100 gallons per minute capacity.

Carbon Dioxide for Fire Fighting.*

Latest Designs in Portable Equipment.

A VALUABLE method of fire protection at electricity stations and industrial establishments now being more and more employed is the use of a permanently installed battery of high pressure cylinders filled with liquid carbon dioxide, situated in some central position, and connected up by narrow bore pipe in the danger points. By opening valves automatically or by hand on a control panel a vast volume of carbon dioxide gas can be poured into the flames, which are thereby smothered immediately because of the dilution of the oxygen of the air below the limit necessary for combustion. Thus an atmosphere containing only about 17 per cent. carbon dioxide will extinguish a fire, and this method is of great value for dangerous fires such as resulting from petrol, benzol, oil, turpentine, paint, varnish and tar.

Well-known specialists in this field of fire fighting by carbon dioxide gas are Foamite Firefoam Ltd., of London (55–57, Great Marlborough Street, W.1.) and considerable interest attaches to the latest designs of their "Alfite" portable equipment which operates on the same principle as the permanent plant, and is suitable for a wide range of conditions. For example, the small hand machine, easily carried by one person, consists of a cylinder containing 7 lbs. weight of liquid carbon dioxide, corresponding to about 60 cubic feet of gas. Included is a short flexible pipe and a wide "spray" head for directing the gas upon the flames, whilst the top of the cylinder has a small valve which on operating allows the gas to escape with great force in the form of a stream.

A larger size containing 12 lbs. of liquid carbon dioxide gas is also available, while another standard "Alfite" portable equipment consists of a large cylinder containing 50 lbs. of liquid gas, fixed in a horizontal position, on two wheels, propelled however to the scene of the fire and operated by one person.

The total weight of the machine is 380 lbs. and 12 feet of flexible hose is provided for directing the 450 cubic feet of gas represented by the above amount of liquid.

It will be remembered that a number of different methods are available for fire fighting

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* Contributed by David Brownlie, 46, Grange Road, Ealing, London, W. 5.

including water, acid-alkali extinguishers, carbon dioxide gas from cylinders, foam, and inert heavy vapours, such as carbon tetrachloride. Two separate principles are concerned, cooling the material to below the temperature necessary for combustion (combination with the oxygen of the air) or diluting the oxygen to the point when it will not support active combustion. As already stated, carbon dioxide acts in this way, and the same applies to carbon tetrachloride, used for motor car extinguishers, whilst water depends almost entirely on the first principle, reducing the local temperature. The firm make equipment using all the above methods, and foam for example, extremely valuable for many conditions, consists of a close aggregation of bubbles formed of a resistant film or skin filled with carbon dioxide gas made by mixing a special alkaline and acid solution. What is the best method to adopt depends upon the exact circumstances, and efficient fire fighting to-day is of course a highly complicated business using a great assortment of fast motor vehicles and rescue apparatus of different types.

Science in the Service of Indian Agriculture.*

THE material results of scientific discoveries have, as elsewhere in the world, greatly benefited rural India and her agriculture. Better transport, better illumination, the rural electric supply, the telegraph and the wireless are all tending to raise the standard of comfort in the villages. An even greater service is the application of the scientific method in the solution of the problems of agriculture which is largely an art and perhaps primarily a business. The conscious application of the scientific method is barely a century old but an immense amount of agricultural lore, gained as the result of experience, has accumulated which is both important and deserves to be scientifically interpreted. In India, the first attempts at improving agriculture took the form of the opening of model farms for copying the methods in vogue in advanced countries. The appointment of American cotton growing experts, the importing of agricultural machinery including steam ploughs and the opening of model farms in Madras, Bengal and the U. P. belong to this phase. The next landmark is the report of the Famine Commission of 1880 and its successor of 1901 to which we owe not only the development of irrigation, communications, rural credit, etc., but also what eventually became the Provincial Departments of Agriculture. The visit of Dr. Voelcker and his most valuable report followed, as likewise successively the appointment of individual experts like Mr. Mollison, Dr. Leather, Dr. Barber and Dr. Butler. In 1904 Lord Curzon's Government made the next great advance which resulted in the creation of the Imperial Department of Agriculture, the opening of the Pusa Research Institute and the starting of properly equipped scientific Departments of Agriculture in the Provinces. Steady progress has followed and thanks to the wise and far-reaching recommendations of the Royal Commission on Agriculture research can now be organised and financed with a precision previously unknown. With the Universities and kindred institutions co-operating with the Agricultural departments the stage has now been set for a great advance in rural uplift.

With this somewhat familiar historical background we may now describe the contributions of the different sciences to the improvement of Indian agriculture using the term however in its narrower sense of mere crop production. This improvement in crop production has been along three directions, *viz.*, the improvement of the plant, its better nutrition and better protection against pests and diseases. More progress has been made in plant improvement than in improved plant nutrition in India for reasons partly economic and partly technical. The rapid advance in the science of genetics and its application to plant breeding has naturally led to much attention being paid to the improvement of the staple crops of the country. As a result, the area under improved wheats alone is well over 10 million acres, to take the case a most important crop. Wheat indeed was one of the first crops to be studied the names of the Howards, of Milne and of Evans being associated with this important work. The varieties originated are all of high merit, one of them Pusa 12 having given double the yield of the local, over a seven-year period of trial. All are also of high milling value and Pusa 12 combines with high yield, earliness, hardiness and good milling and baking quality. The Pusa improved tobacco is a cross between the Adcock and the Pusa 28 and combines the excellence for cigarette making with the valuable agricultural features of the local parent; the improved linseed of Pusa combines the root system and the agricultural habit of one type with the high oil content of another; and the types of *Cajanus indicus* evolved in Pusa are largely resistant to the wilt disease.

The work on sugarcane improvement at the Coimbatore Research Station has resulted in the production of highly satisfactory crosses between the wild cane and the noble or tropical cane, eminently suitable for cultivation in Northern India where they now occupy some 60% of the total cane area of India. In the improvement of the cotton crop, tests for the spinning quality of the various strains evolved by plant breeders are systematically carried out at the Cotton Technological Laboratory of the Indian Central Committee, so that improved cottons undergo a rigid test on this important requirement of quality before they are pronounced as really

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* Summary of a lecture delivered by Sir Boyce C. Burt, at the Twenty-third Annual Meeting of the Indian Science Congress, Indore, 1936, on 3rd January.

improved strains. In this particular aspect of cotton improvement work, India can be said to be ahead of other cotton growing countries and our Technological Laboratory is in many ways a unique institution. The result of all this work on cotton improvement is that quite 4 million acres are now under these improved varieties and that but for this development India will be importing foreign cotton to the value of some 7 crores of rupees.

In respect of better plant nutrition the second line of improvement work has somewhat lagged behind. Numerous experiments have brought out however the great deficiency of nitrogen in Indian soils, the need for organic manures, of aeration and of drainage. All of these have been emphasised and composts and green manures studied and recommended. Work on soil colloids, on the laterite soils of Eastern Bengal, on rice and sugarcane soils in the Bombay Deccan and the C. P. is in progress as well as a comprehensive scheme for the study of dry-farming methods. Problems of excess water, of waterlogging, alkali troubles and kindred matters relating to irrigation are also receiving attention. In regard to artificial manures they have been found to be economic under certain circumstances and India now uses not only the whole of her local production of 13,000 tons of ammonium sulphate, but also had a net import of 38,000 tons in the year 1934–35. Field experiments covering manurial and other problems have become more precise in lay-out and interpretation, thanks to the aid of mathematical technique furnished by the Research Council.

The third division in crop improvement relates to the avoidance or reduction of losses caused by plant pests and diseases. These levy a heavy toll on agricultural wealth and there is need for all the help science can give. Taking sugarcane for instance, these pests comprise moth borers, the Hispa beetle, the cane hopper, mealy bugs, white fly and termites. By suitable varieties, cultivation methods and dusting with insecticides some of these can be controlled and biological methods also hold out promise. The pink boll-worm of cotton and the spotted boll-worm cause large losses annually, but simple methods of control have been devised and demonstrated, *viz.*, the heating of the seed in the first case and the removal of the cotton stumps after harvest in the second case. The heating of the seed has been found to impair neither the vitality nor the oil content of the seed.

Plant diseases are caused by fungi, bacteria or viruses and the best weapon to fight them with in India is the use of immune or resistant varieties, coupled with proper cultivation and rotation methods. Direct methods are also economic, and good instances of such work are furnished by Mysore where spraying arecanuts to prevent the nuts dropping and the coffee bush to prevent leaf disease is extensively practised.

Among improved implements, mention may be made of the large number of improved ploughs being sold annually and of that most recent introduction, the pneumatic tyre for bullock carts. The latter has been found to result in 50% increase in the hauling capacity, in less strain and jerking and fewer sore necks.

The scientific worker in India will find a wealth of material for research in agricultural problems intricate enough for the most ambitious. In all applied sciences, the most important problems often lie on the border line of two or more pure sciences and their successful solution leads to an advance in general knowledge or to the opening up of new fields of scientific investigation. [The address was profusely illustrated by a splendid set of lantern slides.]

Preparation of Fine Chemicals in India.

A SYMPOSIUM on the scope of preparation of fine chemicals in India was held at a meeting of the Chemistry Section of the Indian Science Congress 1936, under the Chairmanship of Dr. P. C. Guha, the President of the Section.

In opening the discussion, Dr. P. C. Guha stressed the desirability of considering seriously the question of preparing fine chemicals in India. A start has been made by the Organic Chemistry Department, Indian Institute of Science, Bangalore, where, since the inception of the Preparation Section in 1930, more than 200 research chemicals have been prepared (some of them in considerable quantities) in an economic way. When an experimental scheme of this nature has to be viewed on a commercial basis, several points demand careful consideration. Now that the preliminary efforts have proved successful, the time has arrived when Indian capitalists should make an attempt at commercialisation. The history of the Eastman Kodak Company of Rochester may be recalled in this connection, and this should serve as a stimulus. India possesses several advantages; for instance plenty of cheap expert and ordinary labour is available. A beginning can be made with the object of meeting the demands of the laboratories. Such an establishment with its *indispensable research section*, could undertake the preparation of other chemicals of general and every-day use in industries and also exploit the possibility of utilising the chemical resources of India. Caution is necessary in such an enterprise and external source of information and experience cannot be depended upon and the necessary technical skill being acquired by Indians themselves. India, like other advanced countries, must pass through a preliminary evolutionary period, but this instead of damping her spirit should make her all the more resolute and active. Prof. Guha appealed to capitalists to utilise the experience already available in the country and explore the possibility of starting industries in this line.

Dr. Wheeler (Bombay) endorsed the President's views and added that some firms in India should take the lead. He felt that the Council of the Indian Chemical Society might organise the production of a limited number of important research chemicals in the various university chemical laboratories. Dr. J. C. Ghosh (Dacca) supporting, instanced the case of a pupil of his, successfully starting the manufacture of gas mantles at Dacca. Dr. N. R. Dhar (Allahabad) felt certain that there is plenty of scope for the

manufacture of fine chemicals in India. He observed that there is no dearth of well-trained chemists in the country, but what is lacking is business experience which is of great importance in running a manufacturing concern. He cited an instance of a properly trained chemist earning Rs. 150 per month by purifying (by recrystallisation) ordinary bazaar chemicals and selling them to the schools and colleges in the United Provinces. Dr. R. B. Forster (Bombay) observed that before the preparation of chemicals could be undertaken, it was essential to have the necessary supply of starting materials and solvents. There is no reason why the distillation of tar should not be undertaken and the importation of raw materials rendered unnecessary. Dr. N. N. Godbole (Benares) opined that fine chemicals can and should be manufactured in India. While pointing out the difficulties in packing and selling, the latter requiring business experience, he suggested the desirability of the Science Congress constituting a body that will analyse and certify the standard preparations. Dr. J. N. Ray (Lahore) was in full sympathy with the views expressed by the President and Dr. Wheeler. He realised that such ventures may not be financially very profitable in the beginning but if the Indian Chemical Society takes the lead, there is no reason why the desired goal should not be achieved. While expressing his disagreement with the view expressed by Dr. Forster, *viz.*, that it is essential to manufacture starting materials and solvents, pointed out the possibilities of exploring new solvents, *e.g.*, furfurol, furyl alcohol, etc., there is no reason why alkaloids, *e.g.*, ephedrine, emetine, etc., as also other useful chemicals from indigenous plants could not be economically manufactured in this country. Dr. J. N. Mukherjee (Calcutta) expressed the view that as a first step, it is desirable to restrict the scope to the preparation of such chemicals as would meet the requirements of research workers in India. By mutual agreement a list might be prepared and the work may be distributed over the different laboratories. Regarding the broader issue of preparations on a commercial scale, he suggested that the first step should consist in collecting information on the possibilities and to have them critically examined by a committee with a view to arriving at definite proposals.

The following resolution proposed by Dr. N. R. Dhar and seconded by Dr. J. N. Ray was unanimously passed at the meeting:—

> "That the Council of the Indian Chemical Society be requested to carefully consider this important question and explore means as to how and on what lines the preparation of fine chemicals can be undertaken in this country."*

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* The following resolution was passed at the annual general meeting of the Indian Chemical Society held on Monday, 6th January, at Indore :

" Resolved that a committee consisting of the following members with powers to co-opt be appointed to consider possibilities of preparing fine chemicals for laboratory use and to collect informations regarding the possibility of new chemical industries in India :

Dr. H. K. Sen (Calcutta); Dr. J. N. Mukherjee (Calcutta); Dr. S, K. Ray (Dhanbad); Dr. P. K. Ghosh (Calcutta); Dr. N. N. Godbole (Benares); Dr. J. K. Chowdhary (Dacca); Dr. N. R. Dhar (Allahabad); Dr. P. C. Guha (Bangalore); Dr. P. C. Mitter (Convener); Dr. T. S. Wheeler (Bombay); Dr. S. G. Sastry (Mysore); Dr. B. Sanjiva Rao (Bangalore); Dr. K. L. Moudgill (Trivandrum); Dr. S. S. Bhatnagar (Lahore); Dr. M. S. Patel (Bombay); Dr. K. H. Hassan (Hyderabad, Deccan); Dr. B. S. Srikantan (Waltair); Dr. N. G. Chatterjee (Cawnpore)."

Progress of Fuel Research.*

THE Department of Scientific and Industrial Research issued the Report of the Fuel Research Board together with the Report by the Director of Fuel Research for the year ended 31st March 1935. The Report is made the occasion for a review of the progress achieved in the Fuel Industry during the twenty-five years of His Majesty's reign. Consideration is given to the relation between the Board's researches and the remarkable changes which are taking place in the utilization of coal.

Despite increasing industrial prosperity and rising population the consumption of coal in Great Britain has fallen from 180 million tons a year in 1910 to 165 million tons in 1934. It is sometimes suggested that this fall is due to the replacement of coal by oil but the report shows that this is largely erroneous and the decrease is due mainly to the increased efficiency of practically every process for which coal is used.

In 1910 about 4½ million tons of coal were required to produce 2,500 million units of electricity, while for the 16,100 million units generated by authorised undertakings in 1934 only 11.4 million tons were necessary. If the efficiency of production of electrical power had remained the same, 29 million tons of coal would have been used in 1934.

An overall thermal efficiency exceeding 27 per cent. has now been obtained in large installations and further major advances in this direction cannot be expected. Incidentally it may be stated that the capacity of individual boilers has been raised from 20,000 or 30,000 to 300,000 pounds of steam per hour, and an efficiency exceeding 90 per cent. has been attained in this section of the plant.

The gas industry has also made great advances, and in the period under review the gas supplied by all authorised gas undertakings in Great Britain increased from 178,000 million cubic feet in 1910

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* Department of Scientific and Industrial Research; Report of the Fuel Research Board for the year ended 31st March 1935, with report of the Director of Fuel Research. His Majesty's Stationery Office, London, xi + 188 pp. Price 3 *sh.* 6*d.* net.

to 295,300 million in 1934, while in the same period the coal used only increased from 15.1 to 17.1 million tons a year. If the efficiency of the process of gas manufacture had remained stationary throughout the period an additional 7.9 million tons of coal would have been needed by the industry in 1934. Coke ovens now supply 18,000 million cubic feet per annum to the gas industry. This closer co-operation between the two sections of the carbonising industry emphasises the need for an examination of the types of coal-blends suitable for coke and gas manufacture, a question that is being investigated at the Fuel Research Station.

The coke-oven industry is closely associated with the iron and steel industries, whose coal requirements have fallen by some 15 million tons a year. A considerable proportion of this is due to reduction in the amount of pig iron produced, but it is claimed by the British Iron and Steel Federation that since 1923, largely from the application of the results of research, £4,500,000 per annum has been saved in the cost of fuel. This figure indicates broadly that about 6 million tons less coal were necessary in 1934 than would otherwise have been the case.

The economies in the use of coal in furnaces have been secured largely by burning it in a form that enables it to be fed at a controlled rate into the combustion space. The greatly increased use of mechanical stokers and of pulverised fuel has given to coal and coke a large measure of the flexibility possessed by fluids such as oil and gas. Quite substantial advances are taking place at present in applying mechanical stokers to comparatively small coal—or coke-burning units such as are installed for central heating.

The use of pulverised fuel has increased in the last five years from $2\frac{3}{4}$ million tons per annum to over $4\frac{1}{2}$ million tons. The Pulverised Fuel report states :—

"Pulverised fuel is used for many purposes and there has lately been a marked expansion in its application to metallurgical purposes, which include heating and reheating billets, smelting and melting, annealing and copper refining. It is of interest to record that at the end of 1933 the first plant for supplying coal ready-pulverised was installed by a colliery in Yorkshire, and that pulverised coal of a standardised calorific value is now being offered from a plant in the London area for delivery in tank wagons to small consumers.

"Though these economies have the immediate result that less coal is mined, the total energy derived from coal and usefully applied was appreciably greater in 1931 than in 1910. The gain in efficiency has an important bearing on the cost of living and the cost of production of manufactured articles."

In the last eight years the amount of coal cleaned has risen from 51.4 million tons or 20 per cent. of the total coal raised to 87.5 million tons a year or 40 per cent. of the total.

The notable advances that have been made in cleaning coal, both by wet and by dry processes, have resulted in a reduction in the amount of inert material that is transported from the collieries and handled, as clinker and ash, after the coal has been burnt; at the same time they have increased the difficulties of disposing of the dirt at the collieries.

Future improvements leading to increased economy in the use of fuel, the Report states, will depend more and more on the selection of the most suitable coal for the particular purpose required, and pre-treatment of the coal before its final combustion will become of increasing importance. The pre-treatment starts at the collieries, where the coal is graded and cleaned as required. The grading may consist of sizing alone, or may include blending the coal from different seams or the separation of the coal from one seam into different portions such as "hards" and "brights". Further pre-treatment consists in converting coal into gas, coke and tar, or its energy may be converted into electricity. The tar, or the coal itself, may be converted into motor spirit or oils.

The programme of research carried out by the Board is related to a greater or lesser extent to all these developments. Good progress is reported in the National Coal Survey which must form the foundation of future development in the use of coal. This work is being carried out in nine laboratories situated in the principal coal fields, and large-scale investigations are carried out at the Fuel Research Station. The object of the Survey is the examination of the coal seams as they occur in the ground and the various grades of coal as they are prepared and marketed by the different collieries.

"There is an ever-increasing movement," Dr. F. S. Sinnatt, the Director of Fuel Research, writes, "to regard coal as raised from the mine as a raw material which must be processed before it is offered for sale. In some respects coal is being viewed in the same manner as raw cotton. Treatment in washing and cleaning plants, screening into suitable sizes, together with the selection of parts of seams or the mixing of two or more seams, are the normal practice of the coal industry. This technique is, however, being rapidly refined, and accurate grading and precise mixing and blending to produce coals of uniform qualities are assuming increased importance. In some cases it would be an advantage if the inorganic matter present in the coal could be reduced to the lowest possible percentage; an extreme case would be the use of pulverised coal in internal combustion engines, should this develop, and there are signs that a demand may arise for "ultra clean" coal. Coal containing less than 2 per cent. of ash may be considered as ultra clean, but lower percentages are possible, and greater demands for coal of this type may be made in the future.'

In this connection, it is pointed out, that the results of the Survey are showing that in practically all the British coal-fields there are seams containing less than 2 per cent. of ash. In many cases a still higher degree of cleanness can be attained. In Durham, for example, the ash content of "brights" from the Plessey seam varies from 0.8 to 2.0. In South Yorkshire, Haigh Moor coal supplied for household purposes contained only 0.8 to 1.2 ash. In South Yorkshire some crushed samples indicated a yield of between 90 and 79 per cent. of coal containing

between 0.5 and 0.8 per cent. ash, and in South Wales two commercial samples were found to contain 0.7 to 0.8 per cent. ash respectively.

In other directions the work of the Survey is assisting in the often difficult problem of identifying coal seams, in districts where, for example, the seam is known by different names or different seams are known by the same name, or where correlation is difficult because of geological "faults". This problem, the Report states, is of importance because a wrong correlation of a seam may, after working through a disturbed area, result in unexpected troubles and danger from water and gas as well as in a waste of effort in searching for seams at a wrong level.

In North Staffordshire survey samples have been taken in a number of cases from seams which are not at present worked. In one case the results proved the seam to be of so good a quality as to justify the immediate re-opening of the mine. In South Wales and in the case of the Busty seam of Northumberland and Durham maps have been drawn showing where coal of various volatile contents occurs, thus enabling any variation in the coal to be predicted as the mines are developed.

Another interesting example of the work of the Survey comes from the Forest of Dean. Here it has been shown that a band of "black dirt" of variable thickness overlying the Coleford High Delf increases not only the amount of ash but also the sulphur in commercial grades, besides having a very deleterious effect on the coal from a carbonisation point of view. This material is similar in appearance and density to the coal itself and therefore does not lend itself to separation by any of the normal methods. It is concluded, therefore, that at present the only satisfactory method of dealing with this problem is to remove the "black dirt" from over the seam before actually getting the coal.

In connection with the preparation of coal for the market, good progress has been made at the Fuel Research Station with the development of methods of cleaning of fine coal and the clarification of washery water, leading to economy in the use of water and the prevention of river pollution. A new dry cleaning process is also being developed in which the unwanted dirt is separated from the coal by jets of air. Problems in connection with the mechanical breaking down of large coal to graded sizes suitable for particular purposes are being investigated.

In connection with the production of motor spirit and lubricating oil from home sources, researches have been continued into the principles underlying the hydrogenation of coal and the hydrogenation-cracking of tars and tar oils, the development of these processes is being studied in technical scale plant in order to obtain sufficient of the motor spirit and oils to test them under practical conditions. The motor spirit is being examined under service conditions. The most important item in this field has been the design and erection of a plant capable of treating about 300 gallons of tar per day, together with the distillation and refining plant required to deal with the spirit produced. Diagrams and descriptions of the plant are given, as well as an account of preliminary experiments to test the various parts and to gain experience in the control of the plant. The results of these experiments, it is stated, have fully justified the erection of the plant; only very minor alterations have been necessary, and little difficulty is anticipated in settling down to normal working at full capacity. It has been found that the technique of hydrogenation does not necessarily require high pressures and thanks to increasing knowledge of catalysts (*i.e.*, substances which hasten the chemical reactions although themselves remaining unchanged at the end of the process) a process has been worked out on a semi-commercial scale at the Fuel Research Station for treating, at atmospheric pressure, acids present in coal-tar from gas works and coke ovens to obtain motor spirits such as benzine.

Considerable progress has been made in the improvement of burners for pulverised fuel furnaces towards overcoming the difficulties of burning low volatile coal, such as some South Wales coal in furnaces, with restricted combustion spaces. Two of these new burners are being manufactured by commercial firms under licence and with one of them—the "Grid" burner—good results have been obtained in a Lancashire burner with a coal containing as little as 15 per cent. of volatile matter. A satisfactory solution has also been obtained to another practical problem presented in the burning of pulverised fuel. In pulverised fuel firing the distribution of the coal particles moving along a pipe or conduit in a stream of air is not uniform as regards the concentration or the size of the particles, so that dividing the stream into equal parts to supply two or more burners from a common stream is extremely difficult. Moreover, fluctuations occur—for reasons that are not fully understood—in the distribution, necessitating frequent adjustment of the burners to a varying supply of coal and air. A study has been made of the problems involved, and the difficulties have been overcome by a device that is at once simple and efficient. It appears, also, that the device can be adapted to other purposes; with slight modification it can be used for sampling, where a small proportion of material must accurately represent the bulk; or, on the other hand, the flow of material can be reversed, and the device will then intimately mix the material fed to it from separate streams. In some commercial installations, where they have been tried, these distributors have led to a reduction in the number of boilers necessary to supply the required load and to considerable saving in labour and fuel through the better reductions in fuel and labour costs through the better control made possible by their use.

The carbonisation of coal is being studied on a works scale in three types of retort—*viz.*, in a setting of horizontal retorts, in narrow vertical brick retorts, and in chamber ovens. Considerable interest attaches to a modified method of operating horizontal retorts, which has been developed at the Fuel Research Station. It has long been the practice to introduce steam into vertical retorts during carbonisation, but certain practical difficulties prevented this being done in horizontal retorts. The Report states that a successful method has now been evolved at the Station and the results show that the output of gas can be increased 8 to 10 therms per ton of coal carbonised, *i.e.*, the thermal yield of gas produced can be increased by about 10 per cent. at very slight extra cost. As nearly

7,000,000 tons of coal a year, *i.e.*, half the coal used in gas works in this country, is carbonised in horizontal retorts the potential value of this work to the gas industry is very great. Several large gas companies have been quick to realise this and have adopted the modification in their works.

"The intermittent vertical ovens," the Report states, "are in use for investigating the effects of blending strongly and weakly coking coals, with and without the addition of coke breeze. The best coking coals have been worked for many years, and in some districts are becoming scarce; it is therefore necessary to know as accurately as possible how good coke can be obtained from coals, or blends, not previously considered as possessing the best coking qualities."

Referring to domestic heating the Report states :—

"The open domestic fire is still a national institution, but is responsible for much direct and indirect waste of fuel, as well as for most of the costly smoke nuisance. Small inefficient industrial boilers also give rise to smoke and waste. The increasing use of gas, coke and electricity is steadily improving the position, and further developments in production of easily-combustible coke and of suitably-designed open grates will accelerate the improvement. The output of free-burning smokeless fuel, produced by carbonising coal at temperatures lower than those of coke-oven or gas-works practice, is gradually increasing. The amount of smoke, especially from small industrial furnaces, can also be reduced by using mechanical stokers and suitable blends of coal, which are now being prepared commercially."

"The optical method devised for the comparison of the densities of smoke emitted by different coals has been utilised to study the effect of coal blending on smoke reduction. The method consists in comparing the density of a column of the smoke passing through an inclined tube situated at the top of the chimney with smoke screens of known density. Preliminary experiments in well and bar grates have shown that the amount of smoke per lb. of bituminous coal can be reduced by 10–25 per cent. by mixing with a low volatile coal."

There are 36 figures which appear in appropriate places and render the explanations very easy to follow.

This is one of the very few technical publications we have seen, which, in our opinion, could be read even by the non-technical man with pleasure and considerable profit.

Recent Developments in the Chemistry of Bicyclic Terpenes.*

THE introductory portion of the address deals in a short but comprehensive way with the homocyclic "bicyclic ring-systems, in general". By means of a chart, an idea is given of the various bicyclic ring-systems which can be constructed with or without bridge members, starting from three, four, five and six membered monocyclic rings, and this is followed by a systematic discussion on the chemistry of the more important members of those of the individual bicyclic rings known to the day, thus bringing into prominence the gaps that remain yet to be filled. The theoretical speculations of Sachse and Mohr on the multiplanar character of *cyclo*hexane and higher carbon rings that led the way to the brilliant investigations of Huckel and his followers to a study of the stereochemistry of bicyclic rings like decalin and hydrindane are briefly referred to. In passing, the interesting case of *cyclo*hexane itself is examined. After shifting the evidence for and against a multiplanar configuration for *cyclo*hexane, the conclusion is drawn that any claim advocating the existence of multiplanar *cyclo*hexane rings has to be accepted with reserve.

The bicyclic terpenes themselves which come in for attention next are conveniently divided into (*a*) Camphane-Fenchane, (*b*) Santane, (*c*) Pinane, (*d*) Thujane, and (*e*) Carane series. The various sections are again divided into subsections, evidently for the purpose of lucid presentation. The outstanding and recent contributions are described and the work done by the President and his students is incorporated at appropriate places.

In the camphane-fenchane series, reference is at first made to the recent syntheses of parent compounds, like *norbornylane* (Komppa and Beckmann, 1934), endocamphene (Lipp and others, 1927), *d* and *l*-epi-camphor (Bredt, Asahina, 1929, 1933), homocamphor (Lapworth and Royle, 1920), and β-homocamphor (Salmon Legagneur, 1931). The very useful "diene" reaction of Diels-Alder as applied to the synthesis of important substances in this series (1929–1931) including camphene and camphor is dealt with. The syntheses of degradation products like camphenic (Lipp, 1914), homo*apo*fenchocamphoric (Bardhan and others, 1935), *apo*fenchocamphoric (Short, 1927) and Balbiano's acids (Bardhan, 1928) are briefly described and those awaiting synthesis are pointed out. The tricyclic compounds derived from members of this

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*In order to draw the attention of the scientific world to some of the important and interesting features of Dr. P. C. Guha's presidential address to the Chemistry Section of the Indian Science Congress (Indore, 1936) not fully covered by the abstract published in a previous issue of the *Journal* (Vol. **4**, No. 7, p. 505) we are publishing above another summary. Chemists in India will feel indebted to Dr. P. C. Guha for his admirable and learned address bearing on an important branch of research in Organic Chemistry.—ED.

group are then referred to, after which a discussion of the Wagner rearrangement and the more recent but related Nametkin rearrangement is taken up. This is followed by a sub-section on the physiological action of compounds of the camphor group in relation to their chemical structure.

In the section on santane series, the recent syntheses of santenic (Komppa, 1932, 1934) and homosantenic acids (Sen Gupta, 1933) and that of ketohomo*nor*camphor (Guha and Ranganathan, 1935) are referred to, amongst other facts. The syntheses of santene (Diels and Alder, 1931) and santene glycol (Mohunta and Ray, 1934) are asol described.

In the pinane series, attention is first drawn to the chemistry of more important members of this group, for which purpose they are divided into hydrocarbons, alcohols, aldehydes, ketones and acids, and dealt with separately. Many a knotty problem in constitutional work amongst these compounds are brought out and fully discussed. The synthetic investigations in the field are then taken up; the partial syntheses of α- and δ-pinenes (Ruzicka and collaborators, 1920–24), the synthesis of norpinic (Kerr, 1928, and Guha and Gaind, 1934) and pinononic acids and that of ketonopinone (Guha and Ganapathi, 1935) find mention. Before passing on to thujane series, certain facts are presented which are compatible only with the assumption that the two rings in pinane are in different planes.

The nature of the difficulties that are confronted in work in thujane series are stated. The *cyclo*-propane ring in thujane skeleton is easily broken up by a variety of reagents, giving rise to six or five membered compounds depending on the way the ring opens. The actual amount of synthetic investigation especially among degradation products would appear to be scanty. The partial synthesis of thujone (Ruzicka and Koolhas, 1932) starting from α-thujaketonic acid and that of *nor*thujane and similar compounds (Zelinski and others, 1924-25) are described.

The address closes with a small section on carane series. The recent syntheses of *nor*carane (Ebel and others, 1929), homocaronic acid (Owen and Simonsen, 1933), etc., are referred to and attention is drawn to the constitution of certain compounds which is by no means certain.

The very useful and complete bibliography at the end comprises more than 200 references grouped according to the subject-matter they relate to.

Indian Central Cotton Committee.*

32nd Half-Hearly Meeting.

THE 32nd Half-yearly Meeting of the Committee was held on the 13th January, with Sir Bryce Burt, President of the Committee in the chair. In the course of his speech, Sir Bryce referred to the passage into Law of the Bombay Cotton Control Act which has for its object the elimination of Goghari cotton from the important long staple cotton areas of the Bombay Presidency. "This piece of legislation will undoubtedly go a long way towards improving the quality of the cotton of the Surat tract. It is a necessary corollary to the intensive work of the Bombay Agricultural Department in the areas which the Committee has financed to a considerable extent." Continuing Sir Bryce said, "You will remember that at our meeting in February 1935, we came to the conclusion that complaints arising abroad regarding faults in Indian cotton were occasionally exaggerated because India was not adequately represented at important International Cotton Congresses. It was decided that the Committee should endeavour to arrange for better Indian representation on the International Federation of Master Cotton Spinners' and Manufacturers' Associations, as we were convinced that at all such discussions India should be represented by qualified and properly instructed representatives who could speak with knowledge and authority on present-day conditions. This will now be possible as the Indian Central Cotton Committee has been made an Associate Member of the International Federation."

Sir Richard Jackson, Chairman, Lancashire Indian Cotton Committee, who is touring in India for the second time on behalf of the Committee, was present at the meeting by invitation. He recounted the various measures taken by his Committee to popularise Indian cotton and instanced a firm with 3 mills and 300,000 spindles which 3 years ago was using only 10 to 20 per cent. of Indian cotton but was now using over 90 per cent. of Indian. The Committee passed the following resolution:—

> "The Indian Central Cotton Committee desires to record its appreciation of the excellent work of the Lancashire Indian Cotton Committee. The large increase in the takings of Indian Cotton in the last 3 years is a striking testimony to the efficiency of their organisation and propaganda."

The Committee endorsed the decision of the Agricultural Research Sub-Committee, to send a member of the Staff of the Institute of Plant Industry, Indore, to Iran (Persia) to make a comparative study of Indian and Iranian herbaceum cottons. This study is to be undertaken with a view to examining the possibilities of growing cottons of better staple in those parts of Gujerat and Kathiawar which at present grow mixed short staple cottons.

The Committee approved a number of new research schemes including a botanical survey of

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* From the reports issued by the Publicity Officer, Indian Central Cotton Committee.

Kathiawar cottons and the extension of several old schemes.

The Committee also considered a very interesting report on the work done by their Physiologist at Lyallpur on the causes of partial failures of the Punjab cotton crop and bad boll-opening. There are indications that the cause has been found and the Committee approved an additional grant for 1936-37 to enable this interesting discovery to be pursued and the causal or non-causal nature of certain organisms which are associated with this "disease" to be studied.

The Report of the Cotton Forecast Improvement Sub-Committee was approved. Very considerable progress has been made in tracing and eliminating source of error in the major cotton forecasts. A Cotton Crop Forecast Improvement Scheme for the Bombay Presidency was sanctioned in 1934 with the object of improving the accuracy of cotton crop forecast estimates for the Bombay Presidency and Sind. The Committee sanctioned the extension of the Scheme for undertaking full programme of work for a further period of 3 years, after which it is hoped that the respective Governments will continue the work at their own expense.

The Progress Reports of the Director of Technological Laboratory, Matunga, and the Publicity and Propaganda Officer were approved by the Committee, who recorded their appreciation of the work of these officers in their respective spheres.

Science Notes.

Fossil Finds in the Wardha District.—Recently the Nagpur Museum received a quantity of fossil wood and other rocks collected on the Arvi Range of the Wardha district by the Assistant Sylviculturist of the Forest Department. Amongst them are the basal portions of two palm trunks which are of interest as they come from a new locality.

They are of Intertrappean age and Mr. V. B. Shukla, Professor of Botany, Science College, Nagpur, has undertaken the study of them in conjunction with Professor B. Sahni of Lucknow and sections are being prepared. So far they appear to belong to the genus Palmoxylon and one of them appears to be an aquatic form.

The same locality has also produced the fossil *Bulimus prinsepii*, zeolistic amygdules resembling nutmegs, tourmaline, quartz, magnetite quartz rock, ferruginous gneiss and sandstone, serpentine, epidote conglomerates, mica schist, granite, ochres, travertine, etc.

* * *

Neanderthalers lived in Italy as well as elsewhere in Europe during the early days of the old Stone Age. This is confirmed according to a report in *Science* (Dec. 20, 1935, Suppl. 7) by the discovery of a second Neanderthaler skull at Saccopastore in the Tiber valley. A Neander skull was found in Italy several years ago, but since it was the only one known, it might have been a "Stray". The discovery of this second skull in the same geological formation and accompanied by the bones of animals used for food, is regarded as strong evidence that Italy once had its population of Neanderthalers. Dr. Blanc of the Geological Institute of Pisa and the Abbe Henri Breuil of the Palæontological Institute of Paris reported the find.

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It is announced that Dr. Lothar F. Zotz, Curator of Pre-History of Breslau, has discovered in Schleswig, a cave where Ice Age cave bears lived and where Ice Age cave men lived after killing the bears. Many implements and utensils made of the bones and teeth of the monstrous bears have been discovered and there are abundant charcoal remains of the old hunters' fires.

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The Flora of Gujerat including Cutch and Kathiawar.—We have recently received a book on the Flora of Gujerat in Gujerati. This is the first of its kind in any vernacular of India, so far published. The book is particularly welcome as an attempt is made for the first time to carry the results of scientific researches to the non-English knowing public and we hope to see this example set by Prof. S. C. Dixit, the author of the book (Prof. S. C. Dixit, Wilson College, Bombay 7) to be followed by others. No emphasis need be laid on the need for books on scientific subjects in various vernaculars. We congratulate Prof. Dixit on his pioneering work.

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The Influence of Method of Picking on the Quality of Cambodia Cotton.—Frequent complaints made by consumers of Indian cottons both in India and abroad as regards the amount of trash present in Indian cottons are mostly due to careless and faulty picking. The method usually employed by the ryots was to let the coolies collect the seed-cotton in gunny bags, who gathered all available bolls indiscriminately, regardless of the fact whether they were fully ripe or green and immature. The kapas were later removed and sold at the nearest shandy without being dried, and the lint obtained from it was generally moist, weak and the seed was found to be green and not fully ripe.

The Madras Agricultural Department recommended an improved method according to which, the kapas were picked only from the fully opened and mature bolls leaving the locules in the plant itself. This not only gave mature lint and ripe seed, but also the seed-cotton contained fewer leaf bits and was generally cleaner than that obtained according to the cultivator's method. Two samples picked according to these two methods were tested at the Technological Laboratory, Matunga. The results showed that cotton picked according to the improved method was superior in all respects. (Indian Central Cotton Committee Technological Laboratory, November 1935, *Leaflet* 5.) It contained a higher percentage of mature fibres, gave 3 per cent. less total loss in the opening and cleaning processes, registered fewer breakages in the ring frame and the yarns spun from it were definitely stronger and less neppy than those given by the sample picked according to the cultivator's method.

* * *

Electrical "Eye".—An electron tube device, sensitive to both visible and invisible light was

demonstrated by Drs. Zvorykim and Morton before the American Association for the Advancement of Science. The Device comprises of an electron image tube of high overall magnification fitted with a fluorescent screen which acts as an artificial retina The incident light (whether in visible or invisible range) operates directly the cathode emitter of this tube, as it is sensitive to radiations over the whole spectrum from 1,800 Å to 13,000 Å. Thus an incident radiation (either in ultra-violet or infra-red portion of spectrum) will cause a visible image to be formed on the fluorescent screen. It is quite possible that this 'Electrical Eye' if developed further, will be of the greatest assistance in solving problems of navigation in fog in water or air, and in astronomical and biological work.

* * *

Disintegration of Atoms.—An electro-magnet weighing 58 tons formerly in use at the Annapolis, U. S. naval wireless station, has been transferred to the physics laboratories at Columbia University in connection with a fresh attack that is to be delivered on the atom. (*Electrician*, Jan. 3, 1936, 2.) The field of 14,000 to 15,000 gauss that can be created by this magnet is 75,000 times greater than that of the earth. Protons and deuterons are to be introduced into this magnetic field and directed under the accelerating chamber devised by Prof. Lawrence of California University. Atomic projectiles with an energy of 15,000,000 V. will be emitted and the maximum energy that the equipment will produce is 20,000,000 V. It is hoped that this will enable the atoms of heavy elements such as gold, silver and lead to be disintegrated and that the creation of radioactive elements more powerful and much less costly than radium will be possible.

* * *

Tobacco plants as tall as trees are among the strange vegetation of the lower Andean country now being investigated by an expedition from the University of California under Prof. T. H. Goodspeed. (*Science*, Dec. 20, 1935, Suppl. 7.) One of the biggest tobacco growths measured by Prof. Goodspeed was sixty feet high. The expedition is engaged primarily in a search for wild relatives of the common cultivated tobaccos, to be used in hybridisation experiments. Seeds of many other kinds of plants, however, are being collected.

* * *

Fire Walking.—The University of London Council for Psychical Research has issued a special report on the recent performances before scientific witnesses of Kuda Bux, the Kashmiri Fire-Walker, who walked bare-foot on charcoal trench fire without apparent injury. According to a *Reuter* message recently appearing in the *Hindu*, the conclusion has been reached that it is possible for a slightly built man with chemically unprepared feet to take four rapid steps on charcoal at 430° without injury to his feet, the average time of contact for each step being approximately half a second. The reasons for the failure of two attempts imitative of Kuda Bux's performance are not clear from these experiments. Sir Leonard Hill suggested that increased immunity from burning was due to the power of the controlling activity of the sweat glands of feet and so they were absolutely dry. It is clear that further experimental research is necessary before the *modus operandi* of fire-walking can be considered to be fully understood.

* * *

Health Conference in Singapore.—The Ninth Session of the Advisory Council of the League of Nations Bureau was held at Singapore on the 15th January. Several representatives of Health departments from all parts of the East attended the Conference which was opened by H. E. the Governor, Sir Shenton Thomas. Lieut.-Col. G. G. Jolly, C.I.E., I.M.S., Public Health Commissioner, Government of India, represented India at the Conference. In the course of his opening remarks, H. E. Sir Shenton Thomas directed attention to the possibility of transmission of disease through the medium of air routes. The delegates discussed the question of the risk to Eastern countries caused by the development of air routes and were particularly concerned with regard to the yellow fever which has so far not extended to Asia. The disease at present was found only in Africa and South America and the first line of defence will be India. The importance of determining by the latest methods, the prevalence or otherwise of yellow fever in countries along the air routes was also stressed.

* * *

Development of Coastal Fishing in Bombay.—Remarkable progress has been made by the Fisheries Department of the Government of Bombay under the direction of Dr. S. B. Sethna. The annual report for the year 1934–35 of the Department of Industries, contains an account of the efforts made by the Department to develop Coastal Fishing in the Presidency. Two motor launches were purchased by the Department and sold to Fishermen on the hire purchase system. These boats were being operated at Jaigad and Ratnagiri and fishermen from neighbouring sites flock to sell their catch to the launches. The fish are rapidly transported to Bombay and arrive from 6 to 8 hours earlier than the catches brought by the ordinary sailing vessels and fetch anything from 60–100 per cent. more price. One more fishing vessel was recently purchased and put into service.

While devoting attention to the development of coastal fishing, the Department has not lost sight of the difficulties experienced in transporting fresh fish to mofussils. It is considered more profitable to increase the fresh fish yield in tanks and wells in up-country areas. As an experimental measure a large tank in the Bandra municipal area has been cleaned out and will be stocked with *Gourami* fish when it gets filled up by monsoon rains. It is also proposed to try experiments with *Calla*.

* * *

Soya bean vs. *groundnut cake.*—So much is being said and written about soya bean or 'wonder bean' as it is often called, that it is worthwhile examining the merits of this bean in relation to other materials abundantly available in India. In an extensive article appearing in *Hindu* (Jan. 22, 1936) Mr. N. has examined the merits of the question and incidentally refers to the work of Dr. McKenzie Wallis who in 1917 and later, investigated the nutritional value of pressed groundnut cake. The results of his work are reported in Vols. 4 and 6 of the *Indian Journal of Medical Research*. The pressed cake contains 9–10 per cent. oil, 44–47 per cent. protein and 24 per cent. carbohydrates. The corresponding

figures for soya bean are 9, 44–45 and 27. In both cases the protein is said to be highly assimilable and both contain similar amounts of phosphoric acid. Dr. Wallis, as a result of his investigations, produced a product called 'Nutramin' containing 84 per cent. groundnut meal, 14 dried milk and 2 sodium bicarbonate which contained abundant protein, sufficient fat and carbohydrate and mineral salts, especially phosphorus and calcium. It possesses good keeping qualities. A case is thus made out for conducting investigations on available food supplies before taking up experiments on soya bean cultivation.

* * *

Grants to Hand-Loom Industry.—The Government of India have published the report on the Tariff Board and Woollen and Textile Industry together with their conclusions thereon. The Board divides the Industry into woollen and worsted industries. While the Government consider that no case for protection has been made out they are impressed with the Board's view as regards assistance to hand-loom and small-scale industry and announce their proposal to grant, for purpose of scientific investigation, 5 lakhs of rupees spread over 5 years to be administered in the same way as is being done for the silk industry.

* * *

In order to stimulate research problems in the field of air hygiene and to gather and disseminate factual information relating thereto, a Foundation called Air Hygiene Foundation of America Inc., has been formed by a large group representing various industries, with headquarters in Pittsburgh, Pa. The Foundation will also co-operate with and assist other agencies active in this field. Dr. H. B. Meller has been appointed managing director. Under his leadership, a comprehensive investigation has been begun at Mellon Institute of Industrial Research, in which the hygienic, technologic and economic aspects of air contamination, especially by dust, in the industries, will be studied.

* * *

It is learnt that a Society for the Study of Alchemy and Early Chemistry has been founded in London. Scholars of international reputation are members of the Council. Regular meetings will be held to read and discuss papers, and a Journal incorporating discussions of papers, special articles by members, etc., will be published. Those who wish to become members may communicate with the Hon. Secretary, Society for the study of Alchemy and Early Chemistry, 8, Bream's Buildings, Fetter Lane, London E.C. 4.

* * *

The Annual meeting of the Association of Economic Biologists was held on 25th January, 1936. At the meeting the following office-bearers were elected. Mr. V. Ramanathan, L.Ag., Cotton Specialist—*President*; Mr. K. K. Rao, Assistant Sugarcane Expert and Dr. T. Ekambaram, Professor of Botony, Madras—*Vice-Presidents*; Dr. S. Kasinathan, Biochemist—*Assistant Secretary and Treasurer*. The retiring President, Mr. K. Ramiah, Paddy Specialist, delivered an interesting and illuminating address on "Genetics in Rice".

* * *

At a meeting held on 30th July, the Central College Mathematical Society, Bangalore, passed a condolence resolution about the death of Mr. V. Ramaswamy Aiyar, the Founder of the Indian Mathematical Society.

* * *

University of Calcutta—Commemoration Day.—The Commemoration Day celebration was held on January 30th. In the course of his speech, H. E. the Governor of Bengal referred to the future of the University and said, "It has grown because it has answered a need among the people of the Province. Its very growth called new aspirations, new problems into being. So long as it sets itself to face these problems and calls forth to the solution all that is best in the coming generation it will not age with passing years. Its youth will be renewed from generation to generation and its strength will stand deeply rooted in the hearts and lives of men and women in Bengal."

* * *

The Diamond Jubilee of the Cuttack Ravenshaw College was celebrated in the College premises on January 18. All the old boys of the College were invited and many of them attended the function from different parts of Orissa. An exhibition of Utkal economic products, in addition to a Flower Show, was held in the College Arts Block. After the annual business meeting was over, Sir Courtney Terrell, Chief Justice of the Patna High Court, addressed the assembly. He spoke on the prospects of the new Province of Orissa, the question of a High Court and the probability of the College growing into a University in the near future. Mr. Bathija, Principal, spoke on the subject of unemployment.

* * *

We are happy to felicitate Prof. Bawa Kartar Singh on his appointment as Head of the Department of Chemistry, Science College, Patna. He is also the Chemical Advisor to the Department of Industries, Government of Bihar. Prof. Singh is well known for his researches in the field of optical activity of organic compounds. He was Professor of Chemistry and sometime acting Principal of the Ravenshaw College, Cuttack.

* * *

Imperial Council of Agricultural Research:—The Director of Industrial Intelligence and Research Bureau has been appointed member of the Imperial Council of Agricultural Research. The Central Provinces have nominated Rai Bahadur R. V. Pillai, Officiating Director, Veterinary Services, as representative of the C. P. on the Imperial Council of Agricultural Research in the vacancy caused by the death of Major R. F. Stirling.

* * *

The Paris International Trade Fair (*Foire de Paris*, will be held from May 16 to June 2. The exhibitors at the last Fair numbered well over 8,000 representing 35 different countries. As additional ground has been acquired to supplement the area of the Exhibition Park (400,000 sq. m.) there will be plenty of space for exhibitors.

* * *

The First International Conference on Fever Therapy will be held in New York City, in September 1936. The object of the Conference is to collect and crystallise available data regarding fever induced by physical and other agencies. Therapeutics, physiological and pathological phases of fever will also be subjects for discussion.

The International Union against Tuberculosis will hold its session in Lisbon, Portugal from September 8 to 10, 1936.

* * *

It is announced that the 2nd International Congress on Mental Hygiene will be held in Paris, from July 27 to 31, 1936.

* * *

It is understood that the International Committee of Weights and Measures have resolved, at a recent meeting held in Paris, that with effect from 1st January 1940 the "Absolute" (practical) system of electrical units should be used instead of the "International" system which is now in vogue.

* * *

Science announces that Dr. J. Shoemaker of the Hague has accepted the presidentship of the International Congress of Surgery to be held in December in Cairo, consequent on the resignation of Prof. Von Eiselberg due to his advanced age.

* * *

The Bausch and Lomb Saccharimeters.—A simple saccharimeter of the half-shadow type, of sturdy construction, in which are embodied features of a commercial instrument most essential to accuracy, ease and simplicity in cleaning and convenience in manipulation, has been described in a pamphlet recently issued by Messrs. Bausch and Lomb Optical Co., Rochester, New York (Agents for India :—Messrs. Martin and Harris Ltd., 17, Princep St., Calcutta). The instrument is provided with direct reading international sugar scale. The polarizer is either of the Lippich or of the Tellet type as the purchasers may choose ; the illumination is provided by a 100-watt-concentrated filament Mazda lamp and a glass filter which has the same optical properties as a 15 mm. column of 6 per cent. potassium bichromate solution. Details can be obtained on application from the manufacturers or their agents.

* * *

A prize of 250 *guilder* has been offered by the Dutch Association for genetics for the best work on the Inheritance of differences in resistance to disease in man and animals. The work must contain a review of the literature, especially regarding diseases of the blood, personal observations and conclusions. Further information can be had from A. L. Hagedorn, Secretary, the Dutch Association for Genetics, Soesterberg, Holland.

* * *

Announcement:—

The India Institute of the Deutsche Akademie at its meeting on January 10th, 1936, decided to offer 16 scholarships in institutions of higher learning in Germany available for Indian scholars of outstanding ability, for the academic year 1936-1937.

The scholarships are as follows.—Medicine, 2 ; Mathematics, 1 ; Indology, 1 ; Chemistry, 2 ; Physics, 2 ; German Language and Literature, 2 ; Engineering, 2 ; Archæology, 1 ; Veterinary Science, 1 ; Agriculture, 1 ; Mining, 1 .

All applications should reach India Institute of the Deutsche Akademie before April 1st, 1936. Applications reaching India Institute later than this date will not be considered. The successful candidates will be notified by air-mail in the month of June, 1936, at the latest.

Applications must *directly* be sent to the following address : Dr. Franz Thierfelder, Hon. Secretary, India Institute of the Deutsche Akademie, Maximilianeum, Munchen, 8, Germany.

* * *

We acknowledge with thanks the receipt of the following :—

"The Agricultural Gazette of New South Wales," Vol. XLVII, Pt. I, January 1936 and Index to Vol. XLVI.

"The Journal of Agricultural Research," Vol. 51, No. 5, September 1935.

"Indian Journal of Agricultural Science," Vol. V, Pt. 6, December 1935.

Department of Agriculture, Dominion of Canada :—

Bulletin No. 92. "Studies in Fruit Diseases VIII.—Preventing Peach Canker." (Publication 480).

"The Philippine Agriculturist," Vol. XXIV, No. 8, January 1936.

"The Allahabad Farmer," Vol. X, No. 1, January 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4335–4339.

"American Journal of Botany," Vol. 22, No. 10, December 1935.

"Communications from the Boyce Thomson Institute," Vol. I, No. 28.

"Journal of the Institute of Brewing," Vol. XLII (Vol. XXXIII, New series), No. 1, Jan. 1936.

Carnegie Institute of Washington : "News Service Bulletins," Vol. III, Nos. 27-31.

"Chemical Age," Vol. XXXIII, Nos. 860-863 ; Vol. XXXIV, No. 864.

"Journal of Chemical Physics," Vol. 3, No. 12, December 1935 ; Vol. 4, No. 1, January 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 13 ; Vol. 69, No. 1.

"Russian Journal of General Chemistry," Vol. V (LXVII), Nos. 8 and 9.

"Journal de Chemie Physique," Tome 32, No. 10, December 1935.

"Experiment Station Record," Vol. 73, No. 6, December 1935.

"Transactions of the Faraday Society," Vol. XXXII, No. 1, January 1936.

"Indian Forester," Vol. LXII, No. 1, Jan. 1936.

"Forschungen und Fortschritte," Vol. 11, Nos. 35 and 36 ; Vol. 12, Nos. 1–3.

Government of India Publications :—"Monthly Statistics of Production of Certain Selected Industries in India," August-October 1935. (Department of Commercial Intelligence and Statistics).

— Do. —List of Publications on Indian Entomology, 1934 (Mis. Bull. No. 7). (Imperial Council of Agricultural Research).

— Do. —"Indian Trade Journal," Vol. CXX, Nos. 1542–1545.

— Do. —"Forest Research in India," 1934–35, Part I.

Government of India Publications :—Department of Industries and Commerce, Bombay: "Annual Report for 1934-35."

— Do. —Lac Research Institute: "Annual Report for 1934-35."

"Quarterly Bulletin of the Health Organization," League of Nations, Geneva, Vol. IV, No. 4, December 1935.

"Scripta Mathematica," Vol. III, No. 4, October 1935.

"Journal of the Indian Mathematical Society," Vol. I, No. 8.

"Medico-Surgical Suggestions," Vol. 4, Nos. 11 and 12.

"Journal of the Annamalai University," Vol. V, No. 1, November, 1935.

"Mathematics Student," Vol. III, No. 3, September 1935.

"Science Forum," Vol. I, Nos. 4 and 5.

"School of Agriculture Memoirs," (University of Cambridge), No. 7.

"Research and Progress," Vol. II. No. 1. January 1936.

"The Micro," No. 3, January 1936 (Post Office Journal of Ceylon).

"Review of Applied Mycology," Vol. 14, No.12; Vol. 15, No. 1.

"Journal of the American Museum of Natural History," Vol. 36, No. 5, December 1935.

"Nature," Vol. 136, Nos. 3451-3452; Vol. 137, Nos. 3453-3454 and Index to Vol. 136.

"Journal of Nutrition," Vol. 10, No. 6.

"Ceylon Journal of Science," Section D, Vol. III, Part 4.

"Science Progress," Vol. 30, No. 119, Jan. 1936.

"Scientific American," Vol. 154. Nos. 1-2.

"Indian Journal of Venereal Diseases," Vol. I, No. 4. December 1935.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. V, No. 4, Dec. 1935.

Catalogues.

Verlag von Gustav Fischer in Jena: "Mitteilungen uber Neuerscheinungen und Fortsetzungen (1936)," No. 1, January 1936.

Wheldon and Westley Ltd.: "Monthly List of Books," January 1936.

Academies and Societies.

Indian Academy of Sciences.

January 1936. SECTION A.—C. V. RAMAN: *First Annual Meeting of the Indian Academy of Sciences.—Presidential Address.* MAX BORN: *Unitary Theory of Field and Matter. I. Classical Treatment. Charged Particle with Magnetic Rest-Moment.* C. S. VENKATESWARAN: *The Raman Spectra of Ortho-Phosphoric Acid and Some Phosphates.*—The step-wise ionisation of H_3PO_4 could be followed from Raman spectra. The structure of PO_4 ion is indicated as tetrahedral. B. SANJIVA RAO AND K. S. SUBRAMANIAM: *The Occurrence of Furan Derivatives in Volatile Oils—III. β-Clausenan and γ-Clausenan.*—γ-clausenan is isomeric with α-clausenan. The methods of isolating the clausenans and their physical properties are described. D. S. NARAYANAMURTHI AND T. R. SESHADRI: *Brucine Sulphate as an Internal Indicator in Titrations with Standard Dichromate Solutions.*—The Brucine sulphate indicator is in certain respects superior to diphenylamine, the colour change from green to bright red being very pronounced. M. RAMANADHAM: *Optic Moments of Organic Molecules in Relation to Crystalline and Magnetic Birefringence.*—The magnetic birefringences have been measured for solutions in carbon tetrachloride of naphthalene, diphenyl and dibenzyl. I. CHOWLA: *Vinogradow's Solution of Waring's Problem* (II). R. ANANTHAKRISHNAN: *The Raman Spectra of Some Organic Liquids under High Dispersion and Resolving Power.*—Benzene, Toluene, Phenol, Chlorobenzene, Pyridine and Cyclohexane have been studied. The structure of the 992 cm^{-1} line of benzene has been discussed in detail. C. V. RAMAN AND N. S. NAGENDRA NATH: *The Diffraction of Light by High Frequency Sound Waves. Part III. Doppler Effect and Coherence Phenomena.*

January 1936. SECTION B.—PRAKASH CHANDRA JOSHI: *Contribution to the Life-History of* Stellaria media *L.*—The megasporogenesis of the plant and the development of the pollen grain have been studied. ALBERTO CARLOS GERMANO DA SILVA CORREIA: *The Mussalmans of Goa.*—The Goanese Mussalmans are a mixed ethnic group, issued of the race crossing between Arabs mostly and the Hindus inhabiting Malabar, Deccan and Konkan. MAKUND BEHARI LAL: *A Review of the Genus* Paramonostomum, *Luhe; with Descriptions of two New Species and Remarks on the Genera of the Sub-Family Notocotylinæ.* C. R. HARIHARA IYER, R. RAJAGOPALAN AND V. SUBRAHMANYAN: *Estimation of Nitrogen by Fumeless Digestion. Part II.—Products of Oxidative Digestion of Organic Nitrogen and the Procedure for their Inclusion in the Estimate of Total Nitrogen.*—The conditions relating to oxidative digestion have been standardised and successfully applied to the estimation of total nitrogen in soils. A. C. JOSHI AND V. RAMA RAO: *The Embryology of* Gisekia Pharnaceoides *Linn.*—A comparison of the embryological features of Phytolaccaceæ, Aizoaceæ and *Gisekia* reveals that the genus *Gisekia* should be placed in Molluginaceæ, a sub-family of Aizoaceæ. S. C. DIXIT: *The Myxophyceæ of the Bombay Presidency, India.—I.*

The National Academy of Sciences:

January 10, 1936. N. K. SAHA: *On the Reconstruction of the Mass-Defect Curve and the Stability of the Beryllium Isotope* Be_4^8. G. R. TOSHNIWAL, B. D. PANT, R. R. BAJPAI AND B. K. VERMA: *Study of Ionosphere at Allahabad.* N. K. CHATTERJEE: *Studies in the Respiration of Mango Leaves.* SHRI RANJAN: *Studies in the Photochemical Action in Plant Respiration.* N. R. DHAR AND E. V. SESHACHARYULU: *Nitrogen Fixation and Azotobacter Count on the Application of Molasses to the Soil in the Field.*—Quantitative experiments show that there is no correlation between the bacterial numbers and nitrogen added thus indicating that agencies other than

azotobacter, such as sunlight and catalysts like iron and manganese also contribute to the addition of nitrogen. G. T. KALE: *Cytophysiological Researches on the Relative Resistance of Wheats to* Puccinia glumarum *Eriks and Henn.* SATYENDRA RAY: *On the Saha-Srivastava Derivations of Rayleigh-Jeans Law.*

February 1st. 1936.—(1) P. L. SRIVASTAVA (Allahabad): *On the Phragmen-Lindelog Principle.* (2) KRISHNA LAL GUPTA (Allahabad): *On the Convergence and the Summability of the Conjugate Series of the derived Fourier Series.*

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THE HILL MEMORIAL PRIZE was awarded this year to Mr. Hrishikesha Trivedi of the Physics Department, Allahabad University. It is awarded biennially on the best research work carried out in the Allahabad University both by students and teachers (excluding the senior ones), during previous two years. The recipient of this year's prize is also the Assistant Editor of the *Proceedings of the National Academy of Sciences.* India.

Asiatic Society of Bengal:

THE 153RD ANNUAL MEETING of the Asiatic Society was held on the 3rd February, with Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., F.R.S., President of the Society, in the chair.

In referring to the demise of H. M. King George V, Sir Lewis said, "Not only as loyal subjects we grieve at the passing of H. M. King George V, but as grateful beneficiaries of the system of government which he personified." He also referred to the death of Rudyard Kipling, Dr. P. T. Bruhl, Lt.-Col. H. W. Acton and Dr. A. C. Woolner.

INDIA'S COAL RESOURCES.

In the course of his Presidential address, Sir Lewis dealt with the problem of the Depletion of India's Coal Resources. From a study of the figures of average annual production and average pit's mouth value per ton of coal for the years 1898 to 1934, it will be seen that a rapid expansion in the demand for Indian coal prevailed up to 1919 when the output reached 22.6 million tons. This expansion was not to continue, for the production of 1934 was only 22.1 million tons and "as the coal fields of India opened in 1919 were able to cope with the existing requirements as well as to develop for the future, the coalfields that have been developed since this date, six in number, have caused a position of potential over-production." "The methods of work in many of the coal mines in India have for many years been such as do not commend themselves to geologists and competent mining engineers. And the tales of fire, flood and subsidence from the Jharia coalfield in particular and the evidence visible to all in the shape of pillars of cloud by day and of fire by night show that the extraction of some 600 million tons of coal between 1898 and the end of 1935 must have meant the depletion of available reserves to a vastly larger extent." Mr. Treharne Rees who was engaged by the Government of India in 1917 to report on the situation in the coalfields of Bengal and Bihar & Orissa, directed attention to four problems, *viz.*, method of extraction, generation of power at the collieries, coking, and handling and despatch of coal at the collieries, and found that considerable economy could be effected under each head. He stressed on the need to improve the methods of extraction and advocated the extensive introduction of hydraulic stowing in the Jharia and Raniganj coalfields. The Coal Committee appointed by the Government of India also referred to the wasteful method prevalent and reported in 1920 that no improvement can be expected without State control of the industry.

The extent of the coal reserves of India of higher grade and therefore the seriousness of the admitted losses in working *vis-a-vis* the available reserves were not known at that time, nor was the extent to which it would be possible by methods of washing to improve the lower grade coals known. "These problems and the question of the reserves of sand available for stowing were therefore entrusted to the Geological Survey of India, for examination." A detailed survey was conducted and the results are incorporated in the 5 Memoirs issued by the Geological Survey of India. Sir Lewis issued in July 1935, a Bulletin on the Indian Coal Reserves "to educate public opinion in India on the seriousness of the situation prior to the introduction by Government of measures of conservation, which, it is no secret, the Government of India has in preparation." In the note on India's coal reserves, it is pointed out that the 4,500 million tons of coal of good quality would be exhausted in 100 years. It also draws attention to the more serious fact that the 1,700 million tons of coking coal so essential to the existence of the iron and steel industry will last on the average only 33 years from 1932, at the present rate of extraction, and with a recovery of 50 per cent.; but that such coal would last 80 years, if, with sand-stowing, the extraction were improved to 80 per cent. The position is very serious and demands the adoption of practicable and suitable remedies. For various reasons it will be necessary to have a state control of the methods of work as recommended by the Coalfields Committee. The improved methods will incidentally entail the extensive introduction of some method of stowing the voids, usually referred to as hydraulic stowing or sand-stowing. There should be a change in the methods of grading coal, so that certificates are issued only for coal as actually exported. This will entail the sampling and analysis of cargoes as shipped.

"Whilst recognising that the coal industry requires a higher price for coal in the interests not only of the industry, but also of the welfare of India as a whole, my personal anxiety has been that this increased price should not be obtained by the industry except in return for the *quid pro quo* of improved methods of work."

In conclusion, Sir Lewis referred to a scheme which the Government of India are understood to have, for enforcing the conservation of coal in India. "My plea to the coal industry is that when this scheme is made public, they do not proceed to decry every part of the scheme that affects them personally, as was done in 1922, but that instead they welcome the scheme as being in the best interests of all in the long run and that they even invite the Government to take a more effective line, if they consider that Government's proposals are not far-reaching."

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Office-bearers of the Society for 1936.—

President: H. E. Sir John Anderson.

Vice-Presidents: Sir David Ezra, Sir Upendra

Nath Brahmachari, Bahadur, Lt.-Col. R. Knowles, Sir B. L. Mitter.

General Secretary: Mr. Johan van Manen, F.A.S.B.

Treasurer: Dr. S. L. Hora.

Philological Secretary: Mr. S. K. Chatterjee.

Joint Philological Secretary: Shamsu'l 'Ulama Mawlawi M. Hidayat Hosain, Khan Bahadur.

Natural History Secretaries: Biology: Dr. Baini Prashad; *Physical Science:* Dr. J. N. Mukherjee.

Anthropological Secretary: Rai Bahadur Ramprasad Chanda.

Medical Secretary: Lt.-Col. R. N. Chopra.

Library Secretary: Dr. A. M. Heron.

Other Members of Council: Mr. Percy Brown, Mr. C. C. Calder, Mr. N. G. Majumdar, Lt.-Col. N. Barwell, Mr. K. C. Mahindra and Mr. M. Mahfuzul Haq.

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The following awards were made.—

Elliott Prize for Scientific Research: The prize for the year was awarded to Mr. Kalipada Biswas of Royal Botanic Gardens, Sibpore, for meritorious publications on the subject of Botany. The prize for 1936 will be for work in Mathematics regarding which a detailed announcement has been published in the *Calcutta Gazette* and the *Bihar and Orissa Gazette*.

The Barclay Memorial Medal: The medal is awarded to Dr. Birbal Sahni, Professor of Botany, Lucknow University, for his long sustained and distinguished labours in the field of Botanical research. This medal is awarded biennially to any individual for conspicuously important contributions to Medical or Biological science with special reference to India.

Joy Gobind Law Memorial Medal: The Medal is awarded to Professor Lew Semenowitch Berg, Chief of the Bureau of Applied Ichthyology and Professor of Geography, State University, Leningrad, Russia. This medal is awarded every three years for conspicuously important contributions to the knowledge of Zoology in Asia.

Indian Physical Society:

THE SECOND ANNUAL MEETING of the Indian Physical Society was held on the 6th January, 1936, in the room of the Section of Mathematics and Physics, Indian Science Congress, Indore, with Prof. A. C. Banerjee, M.A., I.E.S., in the chair.

As a result of scrutiny of the ballot papers the Council for 1936 was constituted as follows:—

President: Prof. M. N. Saha, D.Sc., F.R.S., (*Allahabad*).

Vice-Presidents: (1) Principal B. M. Sen, M.A., I.E.S. (*Calcutta*); (2) Prof. G. R. Paranjpe, M.Sc., I.E.S. (*Bombay*).

General Secretary: Prof. D. M. Bose, M.A., Ph.D. (*Calcutta*).

Treasurer: Prof. P. N. Ghose, M.A., Ph.D., Sc.D. (*Calcutta*).

Members of the Council: (1) Prof. K. Prasad, M.A., I.E.S. (*Patna*); (2) Prof. J. B. Seth, M.A., I.E.S. (*Lahore*); (3) Dr. S. K. Banerjee, D.Sc. (*Poona*); (4) Prof. B. B. Ray, D.Sc. (*Calcutta*); (5) Prof. N. R. Sen, Ph.D., D.Sc. (*Calcutta*); (6) Prof. H. P. Waran, Ph.D., D.Sc. (*Madras*).

February 8, 1936.—At a special meeting held in the Chemistry Lecture Theatre, University College of Science, Calcutta, the following papers were read:—

Prof. M. N. Saha—The Origin of Mass in Neutrons and Protons. H. K. Trivedi—The Nature of Binding in $SnCl_2$.

Indian Chemical Society:

December 1935. DINES CHANDRA SEN: *Studies in the Camphor Series. Part II.—Synthesis of isonitrosothiocamphor and its Application as an Indicator in Acidimetry and Alkalimetry.* N. R. DHAR AND S. K. MUKHERJI: *Denitrification in Sunlight and its Retardation. Part II.* SUSIL KUMAR RAY: *Parachor and Ring Structure. Part II.—The Spatial Configuration of Bridged-ring Compounds.* MAHAN SINGH AND MANOHAR SINGH: *Studies on Optical Activity and Chemical Constitution. Optically active Acids and Bases—Part II.* N. R. DHAR AND R. N. MITRA: *Condition of Iodic Acid and Iodates in Aqueous Solution.* VISHWANATH SHARMA AND SIKHI BUSHAN DUTT: *Metallic Titanium in Organic Synthesis.* SUSIL KUMAR RAY: *Parachor and Chemical Constitution. Part IV.—The Structure of Aliphatic Diazo-compounds.* KUVERJI GOSAL NAIK AND BANSIDHAR VITHALDAS MEHTA: *Mercury Acetamide as a Mercurating Agent. Part II.—Mercuration of Phenols.* DATTATRAYA BALKRISHNA LIMAYE AND GOVIND RAMACHANDRA KELKAR: *Action of Acetic Anhydride on 2-Acetylresorcin. A New Method for the Synthesis of γ-Resorcylic Acid.* DUKHAHARAN CHAKRAVARTI AND BAIDYANATH GHOSH: *Synthesis of Coumarins from Phenols and β-Ketonic Esters. Part V.—Constitution of Chlororesorcin and Chlororesorcylaldehyde.* KALI PADA BASU AND SACHINDA NATH SARKAR: *A Semi-micro Method of Determining Total Nitrogen of Air-dry Soils.* S. S. BHATNAGAR, M. B. NEVGI AND MOHAN LAL KHANNA: *Ionic Susceptibility of Rubidium from its Different Salts in the Solid and in the Dissolved State.* P. G. DESAI AND A. M. PATEL: *Solubility of Benzoic and Salicylic Acids in Mixtures of Organic Solvents.* R. M. HALASYAM: *A Note on the Constitution of Formic Acid and Formates.*

Indian Botanical Society:

THE ANNUAL MEETING of the Indian Botanical Society was held at Indore (C.P.) on January 6th, 1936. The following office-bearers were elected for the new year:—

President: Dr. S. R. Bose, M.A., D.Sc., F.L.S.

Vice-Presidents: (1) Prof. P. Parija, M.A., I.E.S.; (2) Dr. K. Bagchee, D.Sc., D.I.C.

Business Manager and Treasurer: Prof. M. O. Parthasarathy Iyengar, M.A., Ph.D., F.L.S.

Councillors: (1) Dr. S. P. Agharkar, M.A., Ph.D., F.L.S.; (2) Dr. B. Sahni, M.A., D.Sc., Sc.D., F.G.S.; (3) Dr. J. H. Mitter, M.A., Ph.D., F.L.S.; (4) Prof. R. H. Dastur, M.Sc., F.L.S.; (5) Mr. K. Biswas, M.A.; (6) Dr. T. Ekambaram, M.A., Ph.D.; (7) Dr. Y. Bharadwaja, M.Sc., Ph.D., F.L.S.; (8) Dr. P. Maheswari, D.Sc.; (9) Dr. S. L. Ghose, M.Sc., Ph.D., F.L.S.; (10) Mr. H. G. Champion, I.F.S.

Member on the Editorial Board: Dr. H. Chaudhari, M.Sc., Ph.D., D.I.C.

Honorary Secretary: Dr. E. K. Janaki Ammal, M.A., D.Sc., Imperial Sugarcane Station, Lawley Road P.O. (*via*) Coimbatore, S. India.

University and Educational Intelligence.

Allahabad University:

Court.—The Court at its meeting held on 4th December, 1935, re-elected Pandit Iqbal Narain Gurtu, M.A., LL.B., as Vice-Chancellor of the University for a further period of 3 years.

Convocation.—On the 5th December, 1935, a convocation of the University for conferring degrees and diplomas was held when His Excellency Sir Harry Haig, Governor of the United Provinces and Chancellor of the University presided. His Highness the Ruler of Bhopal delivered the Convocation address.

Degrees.—The degree of Doctor of Science was conferred on Messrs: (1) P. K. Sen Gupta, (2) D. N. Chakravarti, (3) G. Gopalarao, (4) N. N. Ghatak.

Staff.—Mr. Dhirendra Varma, Head of the Hindi Department and Mr. R. K. Saksena have returned from Europe after taking the degree of D.LITT. and D.SC. respectively from the University of Paris.

Special Lectures.—Prof. Noguchi, Poet-Laureate of Japan who was invited by the University delivered two lectures on "Some Aspects of the Arts and Literature of Japan."

Appointments.—Mr. Hari Har Prasad Dube, B.A., has been appointed as Chief Instructor of Physical Training with effect from January, 1936.

Annamalai University:

Special Lectures.—Under the auspices of the University, the following gentlemen delivered courses of special lectures during January 1936, on the subjects noted against their names:—

Mr. K. R. Subrahmaniam, Professor, Maharajah's College, Vizianagaram; three lectures on "The Ikshvakus of Andhra".

Prof. A. Gopala Menon, M.A., B.COM. (Lond.), Maharajah's College, Trivandrum, three lectures on "Agricultural Indebtedness and Some Remedies."

Dr. B. L. Manjunath, M.Sc., D.Phil. (Oxon.), four lectures on "The Chemistry of Plant Products."

Prof. Yone Noguchi of Japan, three lectures on "Japanese Arts and Poetry".

Technology.—The Syndicate has appointed a Special Committee to investigate the possibilities of starting at an early date a department of Oil Technology in this University. A draft scheme involving a recurring cost of Rs. 16,070 and a capital expenditure of Rs. 70,000 suggested by its Sub-Committee is under consideration.

New Degrees.—It has been decided to institute a Ph.D. degree awardable on the basis of a thesis embodying the results of approved research work done for a prescribed period. Regulations governing the award of the degree are under consideration.

Deputations.—The following members of the Staff attended, as delegates of the University, the Conferences noted below:—

Prof. Rao Sahib C. S. Srinivasachariar and Prof. K. Rama Pisharoti.—The All-India Oriental Conference at Mysore.

Mahavidwan R. Raghava Ayyangar.—The First All-India Oriental Poets' Conference, at Mysore.

Prof. A. Narasinga Rao and Mr. B. Ramamurti.—The Mathematical Conference at Delhi.

Dr. B. V. Narayanaswami Naidu and Mr. M. K. Muniswami.—The 19th All-India Economic Conference at Dacca.

Dr. S. Ramachandra Rao.—The Annual Meeting of the Indian Academy of Sciences, Bombay.

The Vice-Chancellor opened the 11th All-India Educational Conference at Nagpur. He has been nominated to represent the University at the Quinquennial Congress of the Universities of the British Empire to be held at Cambridge in July, 1936.

Mr. R. G. Grieve, M.A., C.I.E., D.P.I. (Madras) (Retired), the representative of the University on the Universities Bureau, has also been appointed a delegate for the Quinquennial Congress.

Aligarh University:

Prof. Max Born's Visit.—Professor M. Born paid a visit to the Muslim University on the request of the authorities from the 5th to the 9th of January. During this time he gave a course of lectures on wavemechanics and a popular lecture and took part in many discussions and colloquia with the Aligarh Scientists concerning the problems now engaging their attention.

Before he delivered the popular lecture, Professor Born was introduced by Dr. Zia-Uddin Ahmed, the Vice-Chancellor of the University, to the staff and students of the University. Dr. Zia-Uddin, in welcoming Prof. Born, paid a glowing tribute to the extraordinary merits of Prof. Born as a scientist of prolific activities. He mentioned particularly his contributions to the theory of relativity, the dynamic theory of crystals and to many problems of atomic and molecular physics. He emphasised the importance of his work which paved the way for the discovery of quantum mechanics, for which his pupil Heisenberg, who worked the last step, was awarded the Nobel Prize. Prof. Born, in expressing his thanks, recollected the many former associations with Dr. Zia-Uddin as his class-mate in Goettingen. He expressed his great satisfaction at the work, which is being carried on in the Physics Department, where his old friend and pupil Prof. R. Samuel continues the tradition of Goettingen with his collaborators.

In the course of his lecture, Prof. Born touched upon the relation between technical and pure science. He was convinced that technical and industrial progress can be achieved best by an efficient education in pure science. This opinion was based on the industrial development of Germany, which he had watched closely for many years and which was mainly due to the pure scientific research work of University professors in their small laboratories.

During his course of lectures, Prof. Born dealt with the wave-mechanical theory of valency; it was interesting to note that he preferred any development in which the basic ideas of Heitler and London's original theory gained more prominence. He welcomed the results of many experimental investigations, carried out in Aligarh which all lead to this view-point.

The visit of Professor Born and his inspiring lectures and presence, have left a deep impression.

Calcutta University:

The following delegates have been appointed to represent the University on the next *Quinquennial Congress of the Universities of the Empire* to be held at Cambridge :—

Mr. Syamaprasad Mookerjee, M.A., B.L., BAR-AT-LAW, M.L.C.

Mr. Bidhanchandra Roy, B.A., M.D., M.R.C.P., F.R.C.S., F.S.M.F.

Prof. Sisirkumar Mitra, D.Sc.

Sir William Ewart Greaves, Kt., M.A., D.L.

The following are some of the subjects suggested by the University for discussion at the above Congress :—

State Control and Universities—particularly in relation to Grants.

Careers for University Students.

Interchange of Professors among Universities of the Empire.

Universities and Secondary Education, particularly in relation to training of teachers.

Availability to Indian Universities of Scholarships and Fellowships awarded in the United Kingdom to Universities of the Empire.

Student Health and Universities.

Dacca University:

At its meeting held on Saturday the Dacca University conferred the honorary degree of Doctor of Science on Sir J. C. Bose and Sir P. C. Roy and the honorary degree of Doctor of Law on H. E. Sir John Anderson, Governor of Bengal and Sir Abdur Rahim, President of the Legislative Assembly. Honorary degrees of Doctor of Literature were conferred on Sir Jadunath Sircar, Poet Rabindranath Tagore, Mr. Sarat Chandra Chatterjee, the famous Bengali novelist, and Sir Muhammad Iqbal.

Delhi University:

Dr. Ruth Young, Principal, Lady Hardinge Medical College, is appointed member, Council of Delhi University, *vice* Dr. C. D. Houlton, resigned.

Mysore University:

Personnel.—(1) Mr. F. N. Mowdawalla, M.A., B.Sc., Mem.A.I.E.E., M.I.E. (Ind.), Principal, College of Engineering, who was on leave, was, on his return from leave, transferred as Chief Electrical Engineer in Mysore.

Mr. D. Srinivasachar, M.A., Professor of Sanskrit, Maharaja's College, whose present term of service expires on the 31st March 1936, has been permitted to retire from the 1st April, 1936.

Meeting of the Academic Council.—A meeting of the Academic Council was held on 10th January, 1936.

Among the decisions arrived at the meeting, mention may be made of the following :—

(1) That candidates successful in the M.A. and M.Sc. degree examinations should be classified in two classes.

(2) That of the four members to be elected by the Academic Council to the Senate, one may be elected from each of the four Faculties (Arts, Science, Engineering and Medicine).

Examinations.—The results of the Pre-Medical and the First M.B.B.S. examinations held in December 1935 were published during the month, as follows :

		Pre-Medical.	First M.B.B.S.
Number Examined	..	28	11
Number Passed	..	20	8
Percentage ..	..	71.4	72.7

Extension Lectures.—The following extension lectures were delivered :—

(*a*) Sir Martin Forster, F.R.S., on "Chemistry in Modern Warfare" in English at Bangalore and Mysore.

(*b*) Mr. M. Hayath, B.E., B.S.E.E., on "Electricity in the Service of Man" in English at Shimoga and Davangere.

(*c*) Mr. A. R. Wadia, B.A., BAR-AT-LAW, on "(1) The State in Contemporary Political Philosophy; (2) The Law of Karma in relation to the Individual and the Society," in English at Hassan.

Spun-Glass Wool.

A new factory for twisting glass fibres into thread or yarn for textiles is being established in Corning, N.Y. by the Corning Glass Works. After 11 years of research, the industrial possibilities of 'Spun-Glass Wool' have been realised, though glass wool was first developed in Germany (*Christian Science Monitor*, December 17, 1935). It is expected that the manufacture of glass awnings, tentage, bed-coverings, tapestry and eventually articles of clothing will become possible in course of time.

The new textile is extremely pliant. The molten glass is forced through tiny orifices under very high pressures. When hardened the fibres are so fine that nearly 90 of them are needed to form the equivalent of No. 60 thread. It can be spun into yarn and woven on standard textile looms and can withstand pressures up to 1,000,000 pounds a square inch. In the chemical laboratory it has been found excellent for insulation and filters.

At the same time, a process is being developed by the Owens-Illinois Company in Newark, Ohio, which enables molten glass to be assembled on a conveyor line in a fluffy mass, a downy substance that can be wound on spools and twisted into silk like thread and yarn on regular textile machines. A few experiments conducted on the new material, such as the knitting of a purse or pieces of embroidery work and the weaving of a glass rug about six feet long and three feet wide—which, curiously enough, cannot be easily distinguished from articles made of linen and other common fabrics—are all indicative of great industrial possibilities, though they are only novelties now.

Reviews.

Vitamins in Theory and Practice. By Dr. Leslie Harris, Sc.D., D.Sc. (Cambridge University Press, 1935.) Pp. 240. Price 8*s.* 6*d.*

Dr. Leslie Harris has produced a pleasantly readable book wherein he conducts us in the space of nine chapters through the vast but fascinating field of Nutrition. He recounts the relevant facts concerning the nature and discovery of the various vitamins, and deficiency diseases caused solely by a lack or deficiency of one or more of the known vitamins are also dealt with, albeit briefly. The nine chapters form a continuous story; the final chapter on "Dietetics—What to eat?" is a fitting conclusion to an interesting story narrated in vivid and fairly non-technical language.

To the advanced student of Nutrition, the book has not much to impart; it is based on a series of four afternoon lectures at the Royal Institution. But the author's aim—to present a readable narrative of that truly romantic subject, the history of vitamin discovery and research—is amply fulfilled. The non-scientific reader will readily derive from the book an insight into the trend of modern nutrition research and its important practical applications. The results of a great deal of experimental work are compactly described, and the reader is spared abstruse details of laboratory technique.

The book is profusely illustrated with photographs, including a considerable number of full-page ones. Its get-up leaves very little to be desired and it is provided with a good index.

S. R.

Essentials of Physiological Chemistry. By Arthür K. Anderson, Ph.D. (John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1935.) Pp. 257. Price 13*s.* 6*d.*

Granted that the notable advances in chemistry in recent years have been in the border line between chemistry and other sciences such as physics, botany, physiology and medicine, a basic knowledge of pure inorganic and organic chemistry is surely essential for a study of physical, physiological or pharmaceutical chemistry. To attempt, therefore, an exposition of physiological chemistry for a student "with a limited preparation in chemistry" is fraught with danger and difficulty. A popular account, addressed solely to the layman, would be understandable; but the book under review essays a serious treatment of a very complex subject, presupposing, however, ignorance on the part of the reader of all but the elements of physical and organic chemistry. To any one who has gone through an Honours school of chemistry, large portions of the book would be a needless duplication of matter found in the common text-books; to the rest they would be more or less incomprehensible. The book itself is exceedingly well written and makes fascinating reading, but it suffers from the limitations of its own objective. One result is a certain lack of proportion; thus much valuable space is occupied in explaining elementary organic chemistry such as osazone formation, the optical activity of tartaric and lactic acids, methods for the estimation of the reducing sugars (with the exclusion of the Lane-Eynon method), the structure of glycerol and the hydrogenation of oils, while a very unsatisfying account is given of the hormones and the vitamins. The sterols get less than a page; the synthesis of thyroxin finds only a passing reference; the syntheses of ascorbic acid are not even mentioned. In view of the work of Mark, Meyer and Haworth on the structure of cellulose, the inadequacy of the latter being summarised in the single sentence "Irvine believes that the fundamental unit in cellulose is a glucose trisaccharide" is apparent. The action of alkali on cellulose does not produce a "a hydrocellulose which is familiar in the form of mercerised cotton". If essential oils are relevant to an introductory course in physiological chemistry, there is little hope of imparting any kind of knowledge of the field in eighteen lines; incidentally it is not easy to see the point in the chemical classification of essential oils into "esters, aldehydes, ethers and terpenes".

One aspect of the book has perhaps been needlessly stressed and it is necessary to reiterate its general excellence. The material is of engrossing interest; a comprehensive and very readable survey has been made of a subject of the utmost complexity. The presentation is lucid and as an introduction to physiological chemistry the book is a valuable addition to the chemist's library.

K. V.

The Systematic Identification of Organic Compounds—A Laboratory Manual. By R. L. Shriner and R. C. Fuson. (John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1935.) Pp. ix+1935. 11*sh.*

Considering the paucity of good manuals for the use of students, the present work of Professors Shriner and Fuson, is most welcome, particularly as it is the outcome of the authors' long and evolved experience in training students of organic chemistry in the University of Illinois. The methods portrayed, therefore, possess the merit of having been tested and tried, and should appeal at once to the student preparing for a University examination and to the research worker.

The book is divided into nine chapters. After an introductory chapter, the student is introduced to solubility tests, by means of which a given compound is brought into one of nine groups based on their solubility behaviours in various liquids. A few fundamental aspects of solubility are discussed, such for instance as the influence of branched chain on solubility, the relation of molecular weight to solubility, an understanding of which will provide some clue as to the nature of the substance. It should be remembered that qualitative analysis demands a critical insight into the operations employed and the analyst has to work not only with open eyes but also with an open mind. From this point of view, the treatment of the subject will commend itself to the students. The use of classification reagents is described in the 3rd chapter and it is emphasised that the reagents are not always specific to single functional groups, but possess limitations. Such limitations are further discussed. The chapter on the preparation of derivatives comprising nearly half the volume is a very instructive one with useful notes and copious tables giving physical constants of important derivatives of a large number of the more common organic compounds. An additional feature is the citation of a few select references to original literature which will prove invaluable.

The book is a very useful addition to the existing literature and will be welcomed by students preparing for University examinations. It may, however, be remarked that important applications of organic chemistry are to be found in the fields of biology and medicine, and more elaborate treatment of naturally occurring organic compounds possessing physiological interest, would have been desired; this is particularly so, because not a few students undergoing preliminary instruction in organic chemistry, later take up the study of biochemistry and medicine, and such a chapter would have formed a useful addition.

Bacteria in Relation to the Milk Supply. By C. H. Chamers. (Edward Arnold & Co., London, 1935.) Pp. 192. Price 6 *sh.*

The book is divided into two parts. The First Part treats of the bacteriological control of milk and is divided into five chapters. The routine examination of milk, the routine examination of water, the causes of taints and abnormal conditions in milk, the isolation and identification of organisms from milk and control of the dairy plant are dealt with in this Part. The Second Part in eight chapters deals with laboratory regulations, cleaning and sterilization of apparatus, preparation of media, isolation and purification of organisms, inoculation, incubation and identification of bacteria.

In the appendices the author has given the important media, composition of stains and chemical reagents for carrying out the work described in the two Parts. A copy of the standard bacteriological tests for graded milk (Memo 139 Food Ministry of Health) is also given. One short chapter is devoted to the description and use of the microscope.

As the author has more or less completely dealt with all the phases of bacteriology in relation to milk supply in the short space available, this small book will be indispensable to dairy students in general and workers in dairy bacteriology in particular. It is interesting to observe that the author has not left the minute details for reference to other higher works on the subject. Examples of these are:—"Counting of bacteria on milk smears", "Calculation of magnification on the microscope", "Measurement of bacteria", "Gram, flagella and capsule staining" and "Filtration". Nature and causes of abnormal conditions of milk, such as bitterness, oiliness, sliminess, fishiness, caramel, phenol and alcohol flavours have also been properly dealt with in this book. Methods have been indicated for testing addition of

colouring matter and preservatives to milk. Under the identification of bacteria, different forms of bacteria have been illustrated. Methods for detection of indol, phenol, acetyl-methyl carbinol, etc., have been given in detail.

Detailed descriptions of some of the ærobic spore-bearing rods, the acid producers, the peptonising organisms and pathogenic organisms occurring in milk are very useful additions.

Although the author has only attempted to present a guide for the routine examination of milk and for the laboratory methods of bacteriological control of milk, the book will be found useful so far as the supply of milk is concerned to dairy students, and as such, it will relieve the teacher of selecting the subject-matter for detailed treatment.

As the author has observed " No publication of this kind can pretend to much originality ", so it would have been very useful to both teachers and students if the author had cited some references at the end of each chapter. It is hoped that the author would rectify this omission in the second edition.

N. V. J.

A Text-Book on Forest Management. By M. R. K. Jerram, M.C. (Chapman and Hall, Ltd., London, 1935.) Pp. x + 156. Price 10*s.* 6*d.*

An American authority defines a Forest as a " Community of living beings of which the most important member is the tree." The management of so heterogeneous a community raises difficult problems which are rendered all the more complex by factors which are extraneous to Forestry proper, but, which, nevertheless, must be taken into account by foresters. (For example, the financial policy of a Government has an obvious bearing on the management of State forests.) Further, some of these complexities are peculiar to individual forests. Very rarely indeed can the general principles of Forest Management be applied to a given Forest without any modification. A text-book on the subject can, therefore, merely expound the first principles, enumerate and perhaps compare well-known methods of Forest Management. It is the merit of Mr. Jerram's volume that within the compass of some 160 pages, he has succeeded in introducing his reader " to all the more important problems involved, to explain the elementary principles on which their solutions are based, and to provide a framework on which a further knowledge may be built up by lectures, reading and study of practice in the forest itself ". (p. v.)

Part I of the book deals with Forest Mensuration. The first principles of measuring stock, growth, increment and yield are clearly explained. It is noteworthy that the author derives his formulæ without the aid of Calculus and his graphical methods give deductions which although correct as a first approximation have the merit of simplicity. Part II discusses the " Preparation and control of a working plan". It is to be feared that in Mr. Jerram's exposition, the control of a working Plan has not received the same attention as its preparation. The most elaborate working Plan is rendered futile, if not properly controlled. And if it be true that in actual practice the control of a Plan—unlike its preparation—does not receive the care it deserves, it is all the more necessary that a text-book should emphasise the dangers attendant on such lapses. Part III of the book is devoted to Forest Valuation and Finance. A summary of the problems dealt with under Forest Finance is masterly in its lucidity and conciseness. It is clearly shown how " there is no such thing as a safe long-term investment outside Forestry. " (p. 102.)

At the beginning of some chapters are given the names of books recommended for consultation. At the end of the volume, there are three appendices ; the first gives a Vocabulary of terms used in Forest Management, the second, a Table of the future values of £1 in N years @ P% compound interest, while the third appendix gives an extract from a Government of India Resolution on Forest Policy. The book is provided with an Index.

Under " Contents," Part III of the book receives the caption " Forest Finance " (p. ix) while in the body of the book (p. 101) the same part is headed "Forest Valuation and Finance". On page 26, in the derivation of the formula for G. S. (Fig. 9), the letters A, B, C, D are first used to represent *rectangles*, and later, the same letters stand for the *altitudes* of the triangles *fab*, *hac*, etc. This is confusing. To refer to formulæ by dates as " 1883 formulæ " (p. 60) is not very elegant. The abbreviation G. S. has been used for the first time on page 3 without

indicating what it stands for. Since the abbreviations employed are many and not always obvious, it would be helpful if an alphabetical list of these with their equivalents is appended to the volume. In the example worked on page 62, in column *f*, the total of 4443 c.ft. is a misprint for the correct figure 4445 c.ft.

This very readable volume forms an admirable introduction to the more exhaustive treatises on the subject.

EMMENNAR.

More Simple Science, Earth and Man. By E. N. Da C. Andrade, D.Sc., Ph.D., F.R.S., and Julian Huxley, M.A., D.Sc. (Basil Blackwell, Oxford, 1935.) Pp. x + 352. Price 6*sh*. net.

This is undoubtedly the best book on elementary science in the English language for school children, and also for those whose education has not included scientific training. The existing practice of teaching science in the secondary schools in water-tight compartments is exposed to the criticism that the pupils get a mass of unrelated facts and obtain no coherent idea of the knowledge placed before them and are generally ignorant of the application of such knowledge to the practical problems of life. This grave reproach to the scientific education in our schools, the book under review removes. It should be welcomed by all the educational authorities and it should replace the books on physics, chemistry, human physiology and hygiene which are individually prescribed at the present moment.

The present volume, which is a continuation of the earlier work '*Simple Science*' by the same authors, is intended to form part of a series of four books adapted for use in all schools. There is one difference between formal text-books on elementary science and those written by Andrade and Huxley. The former are written and taught in the hope that the young pupils would become specialists in some branch of science. But the latter attempt to give the young men a wider view of the scope and applications of science, and this makes all the difference between true education and pseudo-education.

It is superfluous to deal with the chapters individually for comment and when we read them our satisfaction was how some of the difficult topics could be rendered so easily understood by every school child who is reasonably intelligent, and how they could be expressed in such simple language. Science is generally understood by the common people as something abstruse and solemn, fit for the absent-minded professor and the precocious students. Here is a book which without sacrificing precision and accuracy deals with the stern realities and the facts of knowledge in a language understood by all.

The last three chapters dealing with '*The Improvement of Living Things*', '*The History of Science*', and '*Science and General Ideas*' present the history and philosophy of science in a manner at once simple and fascinating. The book is profusely illustrated.

Modern Science. Book II. Chemistry. By G. W. Manfield, B.Sc. (Lond.). (Messrs. Macmillan & Co., London, 1935.) Pp. 156. Price 2*s*. 3*d*.

This fine little book is the second in the series of books on modern science, designed by the publishers. This book deals in a simple manner, with a few substances and their reactions having every-day interest. No reference to the theories on which the science is built is made and symbols and formulæ are not made use of in the course of the discussion.

The book is divided into twelve chapters, each chapter dealing with, in order, air, oxygen, water and hydrogen, water and other liquids, coal, coal gas and petroleum, iron and steel, more useful metals, acids and their uses, alkalies and soap industry, salts and their uses, chemistry in the garden, and the foods we eat. It will be seen that the subjects dealt with are of every-day interest, a knowledge of which is the barest essential in the modern days. Not only can the lay reader use this book, with great advantages for enriching his general knowledge, but the young student, just introduced to chemistry in the secondary schools, will find in this book matter that will prove profitable to him.

The subject-matter in the book is dealt with in a simple language and in conversational style, so that the young pupil will feel quite at home with the reading of this little book. At the end of each chapter a summary is provided. The diagrams are copious and neat.

A list of useful books of reference, an exhaustive set of questions, based on the

subject-matter in the book, and an index make the book particularly attractive.

Europe. By Samuel van Valkenburg and Ellsworth Huntington. (John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1935.) Pp. x+651. Price 23*s.* 6*d.*

At the present day, the world civilisation is European. The nations of the Americas and Australia claim alike to be descended from an European stock in blood and culture. The oriental countries are rapidly Europeanising themselves. This well-nigh universal admiration for Europe provides the strongest evidence that Europe is still the most dominant continent. In order to understand how great this dominance is, it is not sufficient to confine ourselves to a study of the contrast that exists between Europe and other continents, but a thorough knowledge of the appearance of the various parts and the economic and cultural status of the individual countries is a pre-requisite. Hence the plan of the present volume has been to devote two-fifths of it to a discussion of Europe as a whole, laying special stress on the systematic way in which the continent is divided into zones of culture, which are coincident with geographic environment.

The book, which is the fruit of personal observation and study, presents the combined view-point and methods of an European and American geographer. The impress of wide travel in Europe and other continents on the part of the authors is manifest in the text. The geographic story of Europe can be narrated in several ways, each having its advantages and drawbacks. The authors have viewed the continent as a whole in its physical, economic and human phases. The physical aspects comprise a review of the location, magnitude, climate, relief in reference to geological origin, the soil and natural vegetation. The discussion of vegetation logically leads to the economic and human aspects of geographic study, and specially to problems of land utilisation and the primary industries of agriculture, forestry and fishing. The next physical aspect is the sources of minerals and power, and these naturally introduce chapters on the development of industries and the evolution of transportation and trade. Next the human stock of Europe, which has done so much to mould the modern Europe is depicted in terms of ethnographic history and political divisions.

The book naturally divides itself into two sets of chapters, those designed to portray a comprehensive description of the climate, the appearance and natural regions of the whole continent, and others which give a detailed account of the regional and political geography of the European countries. The section of the book dealing with the climate and relief lays a foundation whereby the succeeding chapters on soil, vegetation, commerce and population build up a picture of the continent as a whole, and is very helpful in preparing the way for the treatment of the individual countries.

The regional geography of any part of the world must needs follow the continental lines, but the unique feature of this section of the book is that the authors have succeeded in presenting a broader view in the understanding of current problems. To the world at large the geography of Europe connotes in a large measure, the geography of countries like the United Kingdom, France, Germany, the U. S. S. R. and Italy. The fates of the smaller countries are in fact determined by the stability of the major ones, as the emergence into being of the Little Entente and the Balkan Entente has amply proved.

That Great Britain has for several centuries occupied a position of outstanding influence in world affairs is universally accepted, although the factors that have contributed to this pre-eminence are debated. The insularity and the location in respect of Europe have above all tended to elevate England to its unique place.

The maritime climate of the British Isles have also played their part in giving England an almost unrivalled place in the field of industry and commerce. The Netherlands and Belgium are another example of how human efficiency in conjunction with a salubrious climate has raised a great nation into industrial and political importance. One of the most distinctive features of French geography is the paramount importance of Paris. The ideal situation of the city and the location in it of nearly all French cultural and political activities, make it a veritable barometer of French prosperity. A counterpart to this French situation is to be found in the all-important Po basin in Italy. Although the Italian Peninsula is centrally situated in respect

of the Mediterranean, the most important factor in the rise of modern Italy is still the Po basin, which is not only due to its economic value but also to the quality of its people as well. Even a cursory glance at a map of Europe shows that central Europe is a region of transition. Nordic Scandinavia, Marine Western Europe, the Mediterranean Southern Europe and the topographically uniform Eastern Europe have effectively hemmed in this zone. The transitional character of this section of Europe is evident both in its climate and vegetation and also in the nature of its industries and the political and social institutions of its people. The Swiss with their ethnographic diversity have evolved political unity and have established a truly federal republic. The economic regeneration of Germany since 1870 is one of the most phenomenal of modern times. Here is proof that national progress rests as much on human effort as on such physical factors like relief, soil, climate and mineral resources. The modern development of Germany unlike that of many other countries is a happy blend of industrial, agricultural, commercial and political recovery. During the World War the German Economic System underwent a drastic change owing to the pressure of the blockade, and the transition from Empire to Republic only increased the difficulties. But Germany has again astonished the world by her adjustment to the altered circumstances. Crop production and livestock have already reached the pre-War figures. The Germans themselves are not satisfied with these achievements. The Treaty of Versailles which is more than obnoxious to the German mind, made Germany look forward to a leader who would wipe out the disgrace of defeat, but the democratic parties lacked leaders. The policy of compromising with the former enemies to procure better international understanding and enduring peace was repugnant to the popular mind. This discontent was intensified by the general depression and the burden of taxes, and so the Nazi régimé under Hitler is a logical development of the countries which have suffered most from the defeat of the Central Powers. Austria is most unhappy. The old Austro-Hungarian Empire was a much better structure economically than either the present Austria or Hungary. The combination of the moderately industrial Austria with the essentially agrarian Hungary was a decided asset—united they prospered, divided they declined. Besides these disadvantages Austria is faced with the Anschlus problem, and has the unenviable task of preserving her integrity from the German or Italian advance.

The resurrection and the separation of Poland from the dismemberment of Russia is one of the many remarkable results of the World War. This is not merely because the recreation of a new state with a population of nearly 30 millions is an unusual achievement, but because it gave new proof that a strong sense of nationality could not easily be stifled and would revive whenever the time is opportune for its assertion. The problem of the Polish Corridor which gives Poland the right to use the Port of Danzig and access to the Baltic is one of the most vexed problems of Central Europe which is unfortunately complicated by ethnographical and economic consideration. Among all the countries of Europe there is none where the influence of geographic environment upon human occupation, temperament and political and social development is more conspicuous than in Russia. The splendid isolation of Russia has contributed not a little to the stability of the Soviet system. Communism is a novel experiment which would have come to nothing like the French Revolution but for the advantage it secured in the geographic location of the country. As yet, however, there is little indication that on their own initiative the Russians can mould a system which will so far overcome their physical handicap as to place them on a level with the countries around the North Sea. In fact the trend of history suggests that in the long run the North Sea countries may take the good and reject the bad of the Russian experiment, thus profiting more than Russia herself.

It is an accepted fact that Europe has greatly benefited by a singular combination of climate, location, mineral wealth and the distribution of land and water. The effect of these has been magnified by a post-glacial amelioration of climate rendering vast ice-bound areas fit for human habitation. On account of this the highly favoured north-western part of Europe has in recent times received groups of people who have by a selective process of migration eliminated the less efficient. Thus, Europe achieved

dominance though it is far from uniform. But one of the most important and least understood facts about Europe's non-uniformity is its great and systematic variation not only from north to south but also from east to west. Another important question is whether Europe with all its advantages will still hold its own in the face of rivalry from newer parts of the World ? The future alone can determine, whether the diversity within the continent will increase as it seems to have done in the past or the late M. Briand's dream of an United States of Europe will come true.

The book is a notable contribution to the already extensive literature on Geography, and is distinguished at once by wide scholarship and vivid presentation. Of the numerous geographical books on Europe, this is entitled to be ranked as one of the best, which students and research scholars can study with profit.

C. N. R. R.

The Mysore Tribes and Castes. Vol. I. By Diwan Bahadur L. K. Anantha Krishna Iyer. (Published under the auspices of the Mysore University, 1935.) Pp. lxxii + 502. Price Rs. 15 or 24 *sh.*

The present volume is intended to be a general prefatory survey of the detailed descriptions of the customs and manners of the *Tribes and Castes of Mysore* which have been published in Vols. II–IV. These sumptuous volumes which are the fruits of indefatigable labour and patient field investigation form an indispensable work of reference to all research workers and students of Indology, providing at the same time a great mass of anthropological matter for the general reading public. Diwan Bahadur L. K. Anantha Krishna Iyer is the most senior Indian anthropologist whose publications have earned for him international reputation, and his works are characterised by sobriety of judgment and dispassionate and scholarly exposition. We congratulate the author and the University of Mysore on the successful completion of a great work.

The book is accompanied by two illuminating introductions by Dr. R. R. Marrat, Rector, Exeter College, Oxford, and the late Professor Sylvian Levi, the eminent Indologist of the Paris University. The prefatory note by the author explains the circumstances under which the work of writing these volumes was entrusted to him by the Government of His Highness the Maharaja of Mysore. Mr. F. J. Richards, who was for a long time Collector of the Civil and Military Station of Bangalore and one of the founders of the Mythic Society, has added a chapter on the *Cultural Geography of Mysore*. There are in all sixteen chapters, to which an appendix on Criminal Tribes is added. Several admirable photographic reproductions illustrate the volume.

"The present work may, in my opinion, be regarded as a model of such sociological research as an Indian student can undertake for the lasting benefit and renown of India." This verdict of Dr. Marrat will be generally endorsed by anthropologists into whose hands this volume might fall. The book confines itself strictly to the level of description of the characteristic habits and manners of the several tribes or social units comprising the entire population of the Mysore State, and the great merit of the book is that equal justice is made to each section of the community so as to provide a clear and comprehensive view of its social stratigraphy. Reading the four volumes together, perhaps the reader may not escape the feeling that there is repetition of a catalogue of disconnected facts, but it must be remembered that the Castes form separate pieces of a hierarchical puzzle, and the treatment of each piece independently, adopted by the author, is in the existing state of public affairs a wise one. The prime object of the author is not to overlook anything, however superficial and unimportant it might at first sight appear, but to subject them to a critical analysis by detailed description of the customs of each social group. This parallel study affords at the same time a cross-section view of the general common practices. Under the stress of foreign influence the old Indian customs are fast disappearing, and the author has done a great service by placing on record a true and faithful picture of the social faiths and practices of his countrymen, which would otherwise be lost to posterity.

The books must have an enduring value, and their author is worthy of great honour. There may be a few details in which we may not agree with the interpretation or view-point of the author, but judged on the whole, the four volumes constitute a significant and memorable contribution to anthropological science.

Mammals of Ceylon. By W. W. A. Phillips, F.Z.S., M.B.O.U. (Duncan & Co., Ltd., London, 1935.) Pp. xxvii + 373. Plates I–XXXVIII. Figs. 55. One map. Price Rs. 10 or 15*s*.

The latest addition to the Mammalian fauna of the Indian region is in the form of a comprehensive account of the *Mammals of Ceylon* by W. W. A. Phillips. The author whose acquaintance with the fauna of the island is due to his stay there for a number of years has brought out what is probably the first collected account of the distribution, characters and habits of the mammals of the island. Much of his knowledge is first-hand and there is very little previous literature to rely upon. In his chapter on the distribution of mammals on the island, the author discusses the geological evidence for the connection of Ceylon with the mainland, and basing his views mainly on those of Wayland, concludes that the recent geological history of Ceylon includes two subsidences and upheavals resulting in a double migration of man and animals from India. But for this the fauna of Ceylon would have been far more interesting than what it is to-day. The Primates are represented by three genera, *Macaca*, *Pithecus* and *Loris*. The last named is evidently the most interesting. It occurs in India also and the author basing his opinions on the work of Osman Hill, recognises three distinct races of the single species, *Loris tardigradus*, *Loris t. tardigradus*, *Loris t. nordicus*. The differences between these races seem to rest mostly on colour and size. Nobody who has any experience of these animals in the field and in captivity would fail to be struck with the great variations in colour and size of these forms. The terminology of the species is very confusing and the reviewer who has had opportunities of examining Dr. Hill's specimens in the Colombo Museum thinks there is really no justification for creating these different races. The climatic conditions in the different regions of the island are so varied that they must profoundly affect, temporarily at any rate, the colour and size of these forms. In India, a single species, *Loris lydekkerianus*, is recognised, which is probably synonymous with *L. tardigradus* of Ceylon.

The insectivore fauna of the island, represented by ten species belonging to four genera are interesting in that eight of these species are peculiar to the island. All the forms belong to the Crocidurinæ, the Soriscinæ being unrepresented in the island. Nearly ninety pages of the volume are devoted to a consideration of the Chiroptera of which there are a large number of species, many of them also represented in India. The carnivore fauna of the island is necessarily poor and Ceylon therefore is not the sportsman's paradise that India is. Of the Felidæ the only animal that offers any interest to the Shikari is the Indian Leopard, *Panthera pardus*, which is widely distributed in the dense jungles of the island. The habits of this form are not different from those of its Indian congener, except that, on account of the relative scarcity of its natural food in the Ceylon jungles, the animal has resorted to feeding on practically every denizen of the forest, with the possible exception of the elephant and the buffalo. Bears are common but the only species represented is the sloth bear, *Melursus ursinus*. A large number of species of rats and mice, animals which are probably the most intimately connected with man, are found on the island. An elephant, peculiar to Ceylon and slightly larger than the Indian form has been called *Elephas maximus zeylanicus*. Of the other mammals the Indian Pangolin, *Manis crassicaudata* is the most important. It is the only edentate in Ceylon and fairly common, though very infrequently encountered, on account of its living in burrows made in inaccessible regions. It lives on ants mainly but in captivity does not mind a varied diet.

The book, which is mainly useful to the layman, is therefore full of information to the collecting naturalist. A variety of information such as measurements of typical adults, distribution, sexual differences, colour, food, breeding behaviour and general habits is given and a complete index of the common English, Tamil, Singhalese and scientific names of the animals is appended. The illustrations which are excellent, include a number of photographs, many of which were taken in their natural environment.

B. R. S.

Electrolytic Oxidation and Reduction. By S. Glasstone, D.Sc., Ph.D., F.I.C., and A. Hickling, M.Sc., Ph.D. (Chapman & Hall, Ltd., London, 1935.) Pp. 420. Price 25/-.

The ninth volume of Dr. Howard Tripp's Monographs on Applied Chemistry maintains the standard of the earlier parts of the series. After a brief introduction on electrolysis one gets to business with a chapter on reversible electrode potentials. A moderately advanced knowledge of physics and chemistry is rightly assumed, since the whole series is intended for the trained chemist who desires to specialise. Beginning with the measurement of electrode potential and the various available methods and standards, polarisation and overvoltage are next considered; the theories of overvoltage are briefly but adequately described. Diffusion phenomena, whose significance in electrolytic reactions is insufficiently realised, are discussed in detail. The wide theoretical basis thus provided is followed up by individual oxidation and reduction processes, the reversible reactions of inorganic chemistry, irreversible organic reductions, irreversible inorganic reductions, the polymerisation of anions, the oxidation of fatty acids and their salts, irreversible organic and inorganic oxidations and anodic substitution being taken in order. The whole book is characterised by the soundness of the theoretical treatment and the wealth of detail. Each chapter is followed by an extensive bibliography. As an authoritative exposition of a branch of applied chemistry which is growing daily in technical importance and as a work of reference the book is invaluable; the technologist, however, would be inclined to regard the compilation of a somewhat perplexing array of electrochemical oxidations and reductions and the citation of literature as uncritical. Thus one obtains a very full account of the electrolytic reduction of nitrobenzene, but no indication is given of its practical futility so far as the manufacture of aniline is concerned. While, therefore, the authors' claim that few data of any importance have been omitted is wholly justified, the technical chemist who turns to the book for practical guidance in the exploration of the commercial possibilities of a given electrolytic method is apt to find some difficulty in seeing the wood for the trees.

K. V.

Forthcoming Events.

Central College Mathematical Society, Bangalore.—Mr. K. Venkatachala Iyengar will deliver a course of eight weekly lectures on "The Recent Advances in the Theory of Integral and Meromorphic Functions with Special Reference to Picard-Borel Theorem and Asymptotic Values."

Erratum.

Current Science, Vol. IV, No. 7, January 1936 on p. 484, *read* S. N. Chakravarti *for* S. K. Chakravarti.

103-36.—Printed at The Bangalore Press, Bangalore City, by G. Sreenivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

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CONTENTS.

Neglected Human Genetics.

FOR millenniums in India the individual has been subjugated to the race in its smaller form of the family. Here there is a traditional feeling for the physical unity between descendants of a remote ancestor, which manifests itself in, what to a Westerner would be, an intolerable right of doddering aunts, uncles and other ancients to interfere in the affairs of the younger members of the family. Lately individualism has become the fashion among some educated Indians; and the sentimental occidental attitude of horror towards death through disease or parturition seems to be gaining adherents among politicians as well as among physicians. The doctrine of metempsychosis may occasionally have produced callousness and hopelessness in the face of physical disability, mental disorders and penury; but it is based upon a belief in man's ability to help himself and eventually to improve his lot. For this reason it is more satisfying to reason than some other attempts to account for the inequality of men. But the great advantage to the race of this working hypothesis is the fact that it gave free rein to Natural Selection.

It is evident that a highly gifted and superior strain of men migrated into India in pre-historic times. They may have come in two main infiltrations both before and after the Vedic period, and they brought some of the best hereditary factors or genes that have appeared in the human race. These men built up a society regulated by a series of well-reasoned working hypotheses. They put the preservation of their genic heritage, and the good of the race before the convenience of the individual.

India is now at a most critical point in her racial history, when certain people wish to rush into an uncontrolled sentimental humanitarianism and haphazard practice of birth control.

Women are listening to the siren song of the birth controllers who promise them (1) more strength, leisure and time to develop their own individuality; (2) fewer and better children. Opponents of this movement can point out that the actual results may be (1) self-indulgence and the bridge-playing female wasters now so prevalent in the West; (2) the circumvention of natural selection by which the best survive and the weaklings die off. Even in the most gifted

families there are undesirables. The recombinations of genes in sexual reproduction are fortuitous, therefore the more children the couple have, the more chances there will be for valuable combinations to appear. If we know that our germ-plasm is tainted with undesirable recessive genes, such as congenital blindness or feeble-mindedness, then we are justified in refusing to risk the perpetuation of these traits. The practice of birth control may therefore be regarded as a recognition of past undesirability among one's ancestors; or a tacit acknowledgment of the probable inferiority of one's own children, with the consequent fear that they will be unable to compete with others.

Those who deplore the fact that India has a higher infant and maternal mortality rate than some Western countries, should consider the question from the viewpoint of the race. The kindly idealism of Christianity has little support in the material world, for it would propose that "all men are created equal". The politicians know that this is false, for are they not leaders who tower above their poor silly fellows, and who will protect these little ones from the wiles of the gifted and unscrupulous? The politicians should spare time to glance at the "Eugenics Review", and at the writings of leading geneticists and anthropologists of the West. They would discover that men acquainted with the laws of inheritance are of the opinion that a high birth and infant mortality rate may benefit a nation, while the reverse may poison a race. Because the rate of propagation in the West has recently been inversely proportional to the mental status of the individual parents, we are already witnessing a rapid increase in stupidity and obtuseness; not to mention what has been called "the triumph of the boob" in large areas in Europe as well as in the American public school system.[1] Evolutionists suggest that because the human mind has at last appeared upon the scene, things are more hopeful. They eagerly anticipate that man will henceforward control his own destiny and perhaps circumvent degeneration, which has been the outcome of all rapidly evolved lines in the past. We have already lost sixteen teeth as compared with most other mammals, and our dentition continues to retrogress. Our bodies bear many resemblances to those of embryo anthropoid apes. More and more frequently the tissues in some of us shake off the discipline of the organized body and revert to the embryonic condition of rapid cell division. This tendency is manifested in cancer, and research has shown that it runs in families, that it is probably inherited. Yet what steps have been taken to sort out the tainted stocks to prevent them from propagating or from tainting other healthy stocks?

What reliable data have we on the effects of hybridization in India? Human groups are all inter-fertile and therefore differ only in minor genetic factors, and are maintained solely by isolation. There is a wide variation in almost every characteristic in any local group. It might be better to encourage the mating of superiors from different races than to allow a high grade individual to mix his genes with those of a low grade individual of his own race. The alleged maladjustments of hybrid populations are at present largely sociological rather than biological.

Professor E. A. Hooton of Harvard University has warned us that "we must cease to delude ourselves with the belief that education, religion or other social amelioration can transform base metal into gold. Intelligent artificial selection should replace natural selection."

Who is to judge which hereditary lines are worth perpetuating and which are not? This must not be left to the individual for, as the old Chinese proverb says, "the great man never feels great, and the small man never feels small". The superior groups will realise their own weaknesses and the inferiors will compensate themselves for their own lack with illusions of importance.

Before we can bring genetical knowledge to aid the future of the human race, we must know what hereditary material is available. We must take stock of our genes, and the only way to do so is by intensive anthropometric surveys and blood grouping. Invaluable data are available among India's large families and endogamous communities. Such a stock-taking is urgently needed in this country before the new influences mentioned early have gained control.

India does not need more chairs of anthropology, with their concomitant lectures and theoretical examinations. We need more reliable data, and individual states and districts could and should set about collecting them as soon as possible. The following is a tentative plan for an anthropological survey of a limited area, such as, Malabar, Mysore or Travancore, by local science graduates,

[1] Riddle, O., 'Confusion of Tongues,' *Science*, 17th Jan. 1936.

the cost of which would not be more than that of a single professorship.

Anthropometric instruments have now been perfected, and because of the simple mendelian inheritance of the human blood groups, these give valuable indications of human relationships and migrations. It should be possible to find two reliable unemployed science graduates, one man and one woman residing in each of five or six centres scattered over the district to be surveyed. These ten or twelve people should meet at the nearest university for an intensive course of training of perhaps eight weeks, similar to an American University Summer Session. Here they would take courses in genetics and gross anatomy, and be trained in the use of the instruments, in blood testing methods and in anthropological photography by an expert with sound biological training. Then they could return to their homes and gather data from the community within reach for ten or twelve months. The data would be returned to the expert for statistical treatment and analysis, and would provide an invaluable record of human traits in different communities and geographic groups. They would be valuable to the sociologists and public health authorities as well as to the geneticist and anthropologist. There are indications that blood group types are correlated with susceptibility and resistance to certain diseases. The effects of balanced and deficient diets are revealed in the proportions of the bones of the face and pelvis. Thus the anthropological data would be of use to research workers in nutrition.

The proposed scheme would also provide, at least temporary occupation for some unemployed graduates of both sexes. The experience they would acquire would be of help to them in finding permanent positions afterwards.

Such an undertaking would reflect credit on any institution or individual who sponsored it, and should appeal to wealthy laymen of different communities who might be induced to contribute towards the cost of the survey.

Nutrition, International and National.

By W. R. Aykroyd, M.D.,
Director, Nutrition Research, I.R.F.A., Coonoor.

DURING the last year the subject of nutrition has received considerable attention from the League of Nations and the related organisation, the International Labour Office. As a result of international discussions, comprehensive schemes for the study and attack of the problem have been formulated, which are likely to have a considerable influence in the spheres of economics, agriculture, and public health.

In the Report of the Director of the I.L.O. to the Nineteenth Session of the International Labour Conference (June 1935), we find the following passage :—

" Though there is still considerable controversy among physiologists as to the minimum needs for healthy subsistence and as to the rations of calories, proteins, mineral salts and vitamins required in different climatic conditions, it is not open to dispute that large masses of people are at present underfed or wrongly fed. .... Every country is faced by a problem of this kind, but its exploration is only just beginning. It may be compared with the problem of medical treatment and maternity care, for which much has already been done wherever a sound system of health insurance has been established. .... If the cure and prevention of disease is a communal affair, housing and feeding, which are the primary requisites of healthy living, are hardly less so. They were certainly not excluded from the purview of the International Labour Organisation by the Preamble to the Constitution, which lays down the 'provision of an adequate living wage' as one of its objectives and declares it urgent to improve conditions of labour involving hardship and privation".

"Looked at from another angle, it is evident that a higher and more variegated standard of food consumption would go far to solve the problem of agricultural over-production.... "

" This question of consumption is not only national but international in its scope. If it is agreed that the only real solution of the problem of economic balance is not through scaling down production but in levelling up consumption, then it follows that the best hope of finding a way out of the present troubles is to raise the standards of the

millions who are now underfed, under-clothed and under-equipped. The cares of the American, Argentine, Australian, Canadian or Eastern European farmer would be conjured away if the urban population of Europe and America could eat even a little more bread, butter and meat per head..... When all other remedies have been clearly seen to fail, it is in this direction that thought will eventually be directed, unless a general regression towards lower standards of living is accepted as the ironical but inevitable outcome of a civilisation condemned to decline through the excess of its own creative ingenuity and technical perfection."[1]

An interesting discussion of the questions raised in these paragraphs ensued at the Conference, in the course of which various delegates stressed the importance of nutrition in relation to agriculture, economic policy, and the purchasing power and health of industrial workers. The Conference adopted a resolution instructing the Labour Office "to continue its investigation of the problem, particularly in its rural aspects, in collaboration with the health and economic organisations of the League of Nations, the International Institute of Agriculture and other bodies capable of contributing to its solution, with a view to presenting a report to the 1936 Session of the Conference."

During the Sixteenth Session of the Assembly of the League of Nations (Sept. 1935), delegates of 12 countries, including the United Kingdom, Australia, the Argentine Chile, Italy, and Sweden, addressed a letter to the President proposing that "the question of the relationship of nutrition to the health of the population, which has become a social and economic problem of widely accepted significance, and is recognised as having an important bearing on world agricultural problems, should be placed on the agenda of the current Session of the Assembly."

This was accordingly done, and the discussion raised lasted three days in the Second Committee—a somewhat remarkable fact when one remembers that the 1935 Assembly was perturbed by the tragedy of the Italo-Abyssinian war. A few months previously a report had been published in the *Quarterly Bulletin of the Health Organisation of the League of Nations* entitled "Nutrition and Public Health,"[2] by Dr. Et. Burnet of Paris and myself. This report, which marshals evidence to show that malnutrition is prevalent throughout the world and outlines the far-reaching implications involved, was to a large extent used as a basis for discussion. In opening the debate, Mr. Bruce, the Australian delegate, used the memorable phrase "marry health and agriculture", which served to crystallise ideas previously nebulous. Other delegates who spoke were in general agreement that the time has come for vigorous action on a national and international scale, and the bearing of the ideal of "improved nutrition" on the economic life of the world was re-emphasised. Increase consumption of agricultural products and the purchasing power of the agriculturist must rise, to the benefit of industry and world trade in general. As a result of its discussions, the Assembly set up a "Mixed Committee," including agricultural, economic, financial, and health experts, who are to submit a general report on the whole question, in its health and economic aspects, to the next Assembly, and further, it instructed the technical organisations of the League to "collect, summarise, and publish information on the measures taken in all countries for securing improved nutrition."

The next necessary step was to define "optimum nutrition" in the light of modern knowledge. This was done in November, 1935, by a Technical Commission, convened by the Health Organisation of the League, which included leading nutrition workers from U. S. A. and various European countries. Its report, entitled "The Physiological Bases of Nutrition,"[3] defines in simple language a series of optimum dietary standards. Those interested should study the report in the original. Among the points emphasised by the Commission were the following:–the importance of a high milk intake, particularly for children and expectant and nursing mothers; the value of green and leafy vegetables, fruit, eggs and unmilled cereals; the undesirability of a high consumption of milled cereals and sugar. It was subsequently pointed out by various authorities that the general adoption of a diet of the type recommended by the Commission would mean, even in a comparatively well-fed country like England, a very great increase in the demand for dairy products, eggs, fruit, vegetables, etc., and that such a demand would enormously

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1 International Labour Conference. Nineteenth Session, Geneva, 1935, Report of the Director, pp. 83-84.

2 June, 1935, Vol. IV, No. 2,

3 *C. H.*, 1197, Geneva, Dec. 1935,

stimulate the agricultural industry. The ideas of our 'over-production' in agriculture, and of restricted production as a way out of the economic depression, seem to be finally defunct. It has become ludicrous to talk of the 'over-production' of foodstuffs in a world, a great proportion of whose inhabitants are living on a diet far below optimum standards.

The fundamental problem (as far as the countries of Western civilisation are concerned) is therefore to stimulate food consumption in the right direction, and this clearly is a problem with many aspects each requiring intensive study. First, there is the question of educating the mass of the people in rational dietetics. There is great scope for advance here, but difficulties should not be underestimated. The average human being is not very teachable about his diet, being convinced that he knows all there is to know about the subject already. Untiring effort is required to make scientific knowledge, even in a rudimentary form, the property of the man in the street. Then there are difficulties inherent in the commercial organisation of the world; vested interests are quick to turn to their own advantage any new movement of this kind, and ingenious advertising of expensive and unnecessary food products might tend to drown the less sensational propaganda of the hygienist.

At best, however, the possibility of improving nutrition by purely educational means is limited. Poverty is a more basic cause of malnutrition than ignorance. To a large extent, as far as the poorest classes in many countries are concerned, diet is determined by income, and without increase in purchasing power no great improvement is possible. Obviously, purchasing power cannot be raised by a wave of the hand. But at least it is possible to investigate on a wide scale the relation between income, the "cost of living" and food consumption, and correlate the conception of a minimum wage with that of a minimum adequate diet. These are questions of special interest to those concerned with labour problems, and they are at present being actively studied by the International Labour Office.

In countries like England, the subsidising of certain branches of the agricultural industry (*e.g.*, dairy products, eggs, fruit and vegetables) would stimulate production, and lower prices to the benefit of the consumer. Again, an increased national expenditure on unemployment benefit, the supply of milk and nutritious meals to school children, pregnant and nursing mothers, etc., an improvement in the feeding of residential institutions under governmental control, would ultimately have a beneficial effect on the health of a large section of the population, and at the same time put more money in the farmer's pocket.

The "Mixed Committee" of the League, which met in February, 1936, under the presidency of Viscount Astor, included representatives of the International Institute of Agriculture, the International Labour Office, and a number of distinguished nutrition, economic, and agricultural experts. In an interesting opening speech Viscount Astor outlined the enormous range and implications of its proposed activities. On the whole he was optimistic :—

"I believe that our final recommendations can and will make an overwhelming appeal to the common sense of the world...... If starting from the aspect of public health and continuing our enquiries through the fields of national agriculture, of world trade, of industrial employment we come to the conclusion that welfare, using this word in its widest meaning, can be immeasurably raised through the application of the results of science, we shall open up a new era of progress to a suffering world."

It is clear that this promising international activity closely concerns India and the East. Before long India will be drawn into the orbit of the investigation, and will be able to benefit from the results of enquiries carried out elsewhere. As a preliminary there is a great deal of work to be done in India to clarify the general situation as regards nutrition. It is first of all necessary to correlate and compare agricultural production, etc., with the food requirements of the population, and incidentally to throw light on the so-called population problem. This, in my opinion, is infinitely the most urgent and important task to be undertaken in connection with nutrition in India; in the absence of this basic information, the possibility of improving the diet of the people on a wide scale cannot be assessed.

On the economic side, investigations among both urban and rural groups are called for; any study of the economic condition of population groups indirectly throws light on diet. In the sphere of public health, more active educational and propaganda work is needed, and a great

deal of further research, involving many areas of the country, into the effects of malnutrition on the individual, should be set on foot.

Present League activities centre round the ideas that the diet of the mass of the population in almost all countries falls below "optimum" standards, that increased demand for nutritious food will result in increased production, and that the world as a whole is capable of a very much greater production of foodstuffs, and in particular of the physiologically most valuable foodstuffs. It is proposed that national and international "food policies" should be boldly constructed on the principles implied in Mr. Bruce's phrase—"marry health and agriculture". If India is considered as a self-supporting unit, the problem takes on a somewhat different complexion; many consider that there is little possibility of the country producing an improved diet for its rapidly increasing population. We need, however, much more information on this point. If, on the other hand, we regard India, not as an isolated unit, but simply as part of the world, the ideas formulated at Geneva seem to become more applicable. It is conceivable, for example, that increase of wealth and purchasing power would enable the country to benefit, by importation of the kind of foodstuffs she most needs, from a world-wide boom in agriculture. At all events, there is no reason why an attempt should not be made, when the fundamentals of the situation have been more fully investigated, to formulate a "food policy" on a national or provincial basis.

An Interferometric Method of Measuring Temperatures and Temperature Gradients Very Close to a Hot Surface.

By L. A. Ramdas and M. K. Paranjpe,
Meteorological Office, Poona.

A STUDY of the variation of air temperature with distance above and below a hot surface is a problem of importance in Physics and Meteorology. When the surface is an infinite horizontal plane and the air temperatures are required only at distances of the order of feet or centimetres, the problem of measuring the temperature is not difficult and may be solved in a variety of ways, *e.g.*, by using ventilated radiation-proof instruments like the Assmann Psychrometer or thermo-couples or resistance thermometers. Such measurements above the bare soil surface and above and below heated plates have been discussed by Ramdas and Malurkar[1] and others. When the investigation has to be extended to within a few millimetres or a fraction of a millimetre, as for example in the dust-free Aitken's layer referred to by Ramdas and Malurkar, the measurement of temperature becomes difficult. This is easily understood because the moment we place any measuring device or element so near to the surface, the isothermal surfaces get disturbed, radiation effects become pronounced and difficult to avoid, and we cannot hope to get accurate measurements of temperature. The method of interferometry, however, provides a simple and elegant solution of the problem. About 2 years ago Mr. Paranjpe undertook an investigation of temperature variations in the air "above" and "below" hot solid surfaces, above evaporating water surfaces, as well as in the interspace between two plates as in conductivity measurements, by using the interferometric method.

Fig. 1 shows the experimental arrangement. Light from a monochromatic source S (a Zeiss sodium vapour lamp) stopped down by a diaphragm DD and rendered parallel by a lens L falls on a plane parallel glass plate P_1 and is partly reflected on to the mirror M_2 and transmitted through a second plate P_2. The beam transmitted by P_1 is reflected at the mirror M_1 and the plate P_2 and then interferes with the other beam. The two beams are seen through a telescope T which can be focussed on the interference pattern. The above arrangement of the interferometer provides necessary facilities for localising the fringes at any point in the path of either of the interfering beams without change of fringe width.

The hot surface above or below which the temperature gradient is to be measured is provided by a brass plate about 13 cms. long, 5 cms. broad and 6 mm. thick with

[1] *Indian Journal of Physics*, 1932, 3, Part I.

arrangements for electrically heating. The heated plate is inserted half-way into the aperture of the interferometer when the distortion of the fringes, above or below the surface as the case may be, due to the temperature gradient in the air near the surface, may be traced with respect to the fringes in the undisturbed portion of the field. The fringes are localised at the hot surface so that both of them can be focussed on a camera placed in the position of the telescope and photographed. The size of the mirrors M_1, M_2 and the plates P_1, P_2 of the interferometer being small, the photographs of the interference pattern were obtained in sections so that in the final pictures the horizontal portions of the fringes were obtained both above or below the hot surface as well as in the undisturbed portion of the fringe system. The temperature of the hot surface was measured by using thermal junctions of copper and constantan and a sensitive galvanometer.

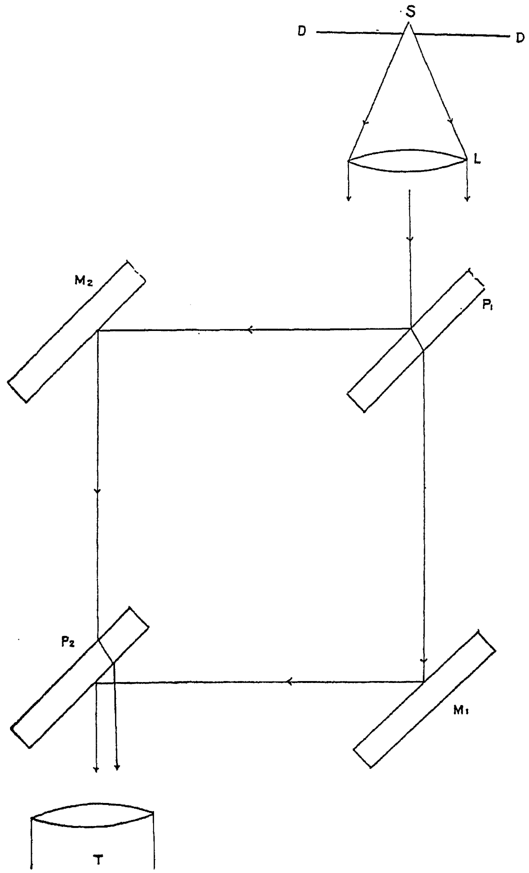

Fig. 1.

Arrangement of the interferometer.

Two interesting cases arise according as the hot plate is inserted between P_1 and M_1 or M_2 and P_2 (Fig. 1).

Case (i):—The interfering wave fronts are, say, OA and OB as in Fig. 2 (*b*) where the angle A O B is shown exaggerated. Let CD indicate the position and width of the

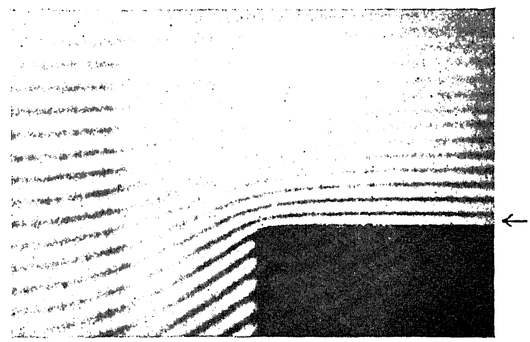

Fig. 2(*a*).

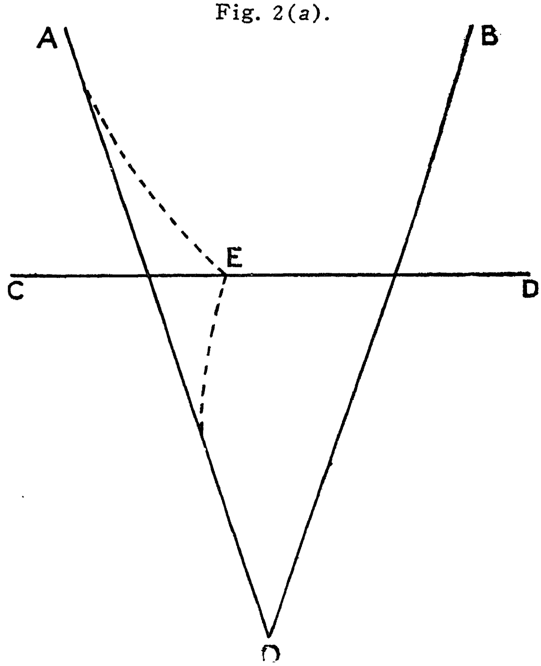

Fig. 2(*b*).

horizontal hot surface which causes the wave front OA to be distorted into A E O as shown by the dotted lines. The distortion will be greatest near CD both above and below, and become negligible some distance away from CD. If one considers the slope of AE in Fig. 2 (*b*) it will be clear that above the surface the system of fringes will move away from the surface. At the

same time the fringes will become narrow, the minimum fringe width occurring nearest to the hot surface. Below the surface the distorted wave front is OE and it will be seen that the fringe system would move towards the surface and widen out at the same time, the maximum widening being nearest to the surface. Fig. 2 (*a*) shows the behaviour of the fringes above the hot surface which is only inserted half-way into the field. The position of the surface is indicated by an arrow.

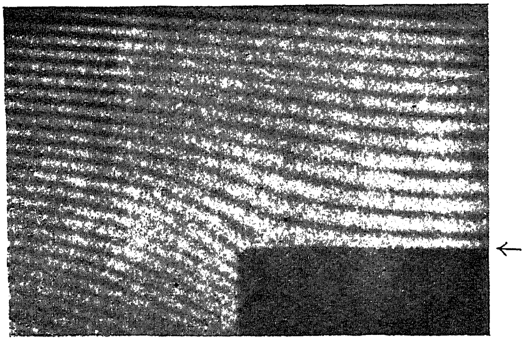

Fig. 3(*a*).

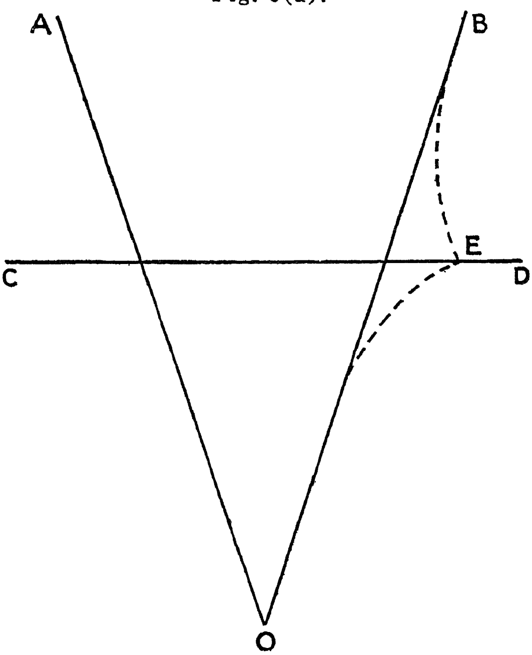

Fig. 3(*b*).

Case (ii) :—Here the wave front affected by the hot surface is OB which gets distorted into O E B as in Fig. 3 (*b*). In this case the movements of the fringe system would be exactly opposite to those observed in case (i), *i.e.*, the fringes above the surface would widen out and move towards the surface and those below would contract and move away from it. Fig. 3 (*a*) shows the behaviour of the fringes above the surface and it will be noticed that the displacement and changes in width are exactly opposite to those in Fig. 2 (*a*). In both Figs. 2 (*a*) and 3 (*a*) the temperature of the surface was 100° C. above room temperature. The left half of the figures shows the undisturbed portion of the fringe system.

Case (i) is to be preferred for the investigation of conditions above the surface as it provides a closer system of fringes for calculating air temperatures, and case (ii) is to be preferred for studying the conditions below the hot surface. In actual working the adjustment for either (i) or (ii) can be made without changing the position of the hot plate, by merely interchanging the positions of the two wave fronts.

The methods of calculating the variation of temperature with height above and below the hot surface and of allowing for the end effects, will be described in a forthcoming paper, where the temperature gradients in the space between two surfaces will also be discussed.

The table below gives an example of the variation of air temperature below the hot surface.

Distance below the surface in mm.	Temperature in °C.	Distance below the surface in mm.	Temperature in °C.
0 (surface)	87·5	0·300	71·2
0·025	82·0	0·400	68·8
0·050	79·6	0·500	66·6
0·075	78·4	0·600	64·4
0·100	77·4	0·700	62·0
0·150	75·6	0·800	60·0
0·200	74·0	0·900	58·0
0·250	72·5	1·000	56·5

Room Temperature = 22°·5 C.

It will be noticed that the temperature gradient is large very near the surface and decreases rapidly as one moves away from it. It is interesting to note that interferometry provides a useful method of making temperature measurements so very close to hot surfaces.

In conclusion we wish to express our best thanks to Professor S. D. Bhave, Sir Parasuram Bhao College, Poona, for the loan of a Michelson interferometer and to Dr. C. W. B. Normand, Director-General of Observatories, for facilities given at the laboratories of the Meteorological Office for conducting these investigations.

Precision Observations on Weather and Crops.

By R. J. Kalamkar, B.Sc., B.Ag., Ph.D. (Lond.)

and

K. M. Gadre, B.Ag.

(*Meteorological Office, Poona.*)

THE earlier researches of Lawes and Gilbert,[1] Shaw,[2] Hooker[3] and others have shown that forecasts of crop acreage and yields can be made on the basis of weather factors. Where adequate data exist such forecasts may be more accurate than those arrived at by the subjective methods used in the official forecasts of most countries. Pioneer work of this nature has been done in India by Jacob[4] and Unaker.[5]

In India, while the official statistics of area sown to different crops are fairly accurate, the data of yield per acre are not so satisfactory. The information collected in the past regarding the various agricultural and meteorological factors concerned has been limited to very rough estimates of the final yield over large areas on the one hand and to certain observations on the "macro" or general climate at the few observatories of the India Meteorological Department on the other. The yield data of the Government Experimental Farms in different provinces are, with a few exceptions, available only for short periods, and systematic climatological data have rarely been maintained.

While some interesting general relationships can be established with these past data,* it is necessary to ensure the collection of more complete information in future years. This involves the recording side by side of systematic, detailed and uniform data of the climatic factors in the actual environment of a crop as well as the life-history of the crop during the growing season. Such information will enable us to study crop weather relationships in all their aspects.

The British Agricultural Meteorological Committee (*vide* Report of the Conference of Empire Meteorologists, 1929, Agricultural Section) having realised the importance of this aspect of Agricultural Meteorology, outlined a detailed scheme called the "Precision Scheme" with a view to record detailed observations on a few crops, according to a specified sampling technique. Our experience at Poona with the micro-climates of different crops [6, 7, 8, 9] suggested that such a scheme to be complete should also include detailed observations of the micro-climate.

In order to develop all the details of a combined "Weather and Crop Precision Scheme" which would be suitable for Indian conditions, the Agricultural Meteorology Branch prepared a draft scheme which was circulated in order to elicit detailed criticisms and suggestions from the various agricultural departments and crop specialists. Their suggestions and remarks have been very valuable in revising the scheme. In order to gain actual working experience of the scheme as well as to decide upon the sampling technique suitable for Indian crops, the Agricultural Meteorology Branch also started precision observations on wheat and jowar at Poona, on rice at Karjat in collaboration with the Crop Botanist, and on Bajri at Baroda in collaboration with the Superintendent of the Baroda Experimental Farm. Some very interesting results have been obtained as regards the stand, growth and yield of these crops. The results in the case of wheat alone are briefly indicated here.

In Table I is given the frequency distribution of the number of plants per quarter metre on the 26th February 1934, observed in 160 quarter metre unit lengths of drill selected according to the sampling technique for wheat.

It is interesting to observe the very wide range of fluctuation of plant density. The estimated average number of plants per

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[1] Lawes and Gilbert, *J. Roy. Agri. Soc.*, 1880.

[2] W. N. Shaw, *Proc. Roy. Soc.*, 1905, **74**, 552–3.

[3] R. H. Hooker, *J. Roy. Stat. Soc.*, 1905, **68**, 285.

[4] S. M. Jacob, *Memo. Ind. Met. Dept.*, **31**, Part XIV, 131.

[5] M. V. Unaker, *Memo. Ind. Met. Dept.*, **25**, 145–61.

* Please see a recent note entitled "Influence of Weather and Prices on the Cotton Crop of the Bombay Presidency," by R. J. Kalamkar in *Curr. Sci.*, 1936, **4**, 484.

[6] L. A. Ramdas, "Micro-climatology," *Curr. Sci.*, 1934, **2**, 445.

[7] R. J. Kalamkar, *Curr. Sci.*, 1934, **3**, 80.

[8] L. A. Ramdas, R. J. Kalamkar and K. M. Gadre, *Ind. J. Agri. Sci.*, 1934, **4**.

[9] L. A. Ramdas, R. J. Kalamkar and K. M. Gadre, *Ind. J. Agri. Sci.*, February 1935, **5**, 1.

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TABLE I.

Frequency Distribution of Number of Plants per Quarter Metre Lengths (26th February 1934).

Number of plants per quarter metre	Frequency
0	27
1	36
2	44
3	24
4	19
5	8
6	1
7	0
8	0
9	1

metre, assuming 80% germination in the laboratory would be as high as 41 at a seed rate of 53 ℔s. per acre (distance between rows being 12″) while at harvest it was as low as 8, the reduction under field conditions being due to interculturing, mechanical injury to plants due to soil cracking and to other damages such as nibbling by rats, etc.

Table II shows the developmental stages of the wheat crop.

A maximum shoot-plant ratio of 5·3 was reached by the middle of December which by harvest time was reduced to 4 on account of the dying off of late formed tillers about the middle of December. More than 50% of the shoots had put forth ear-heads by the middle of January and about 90% by harvest time. The average number of ears per plant at harvest was 3·5. The yield of grain and straw per metre length as estimated by sampling was 25·5 gms. and 49·0 gms. respectively while the actual yields were 23·3 and 50·5 gms. respectively.

Such quantitative measurements of plant growth enable us to determine the principal events which mark the progress of the crop from germination to maturity and if the observations are made in a similar manner at a number of centres over a long series of years, it will be possible to study crop-weather relations in all their aspects.

In conclusion the writers wish to express their best thanks to Dr. L. A. Ramdas, Agricultural Meteorologist for his suggestions during the course of this investigation.

TABLE II.

Developmental Stages of the Wheat Crop.

Date	Plants per metre	Shoots per metre	Shoot : plant ratio	Height in cm.	Number of green leaves per plant	Number of ear heads per metre	General Remarks
5th Nov. 1933	15·7	27·5	1·75	2·51	2·94		(1) Sowing was done on 14th October. Germination was complete by 21st October 1933.
13th Nov. 1933	13·8	44·8	3·25	3·74	3·73		
18th Nov. 1933	13·9	56·9	4·10	4·68	3·55		(2) Interculture with slit-hoe on 22nd November 1933.
25th Nov. 1933	11·9	56·7	4·77	6·34	4·24		
2nd Dec. 1933	10·0	51·9	5·17	7·55	4·78		(3) Cracking of soil observed on the 9th December 1933. Lower leaves turning yellow and found drying by the end of December.
9th Dec. 1933	9·2	47·5	5·17	10·05	5·19		
16th Dec. 1933	8·9	45·8	5·30	13·88	5·56		(4) Rust noticed on the 13th January 1934.
23rd Dec. 1933	9·4	42·9	4·55	23·83	5·60		
30th Dec. 1933	10·4	47·0	4·52	31·01	5·74	1·5	(5) Crop harvested on the 26th February 1934.
6th Jan. 1934	9·8	38·8	3·98	38·82	5·28	7·7	
13th Jan. 1934	8·8	36·4	4·12	46·88	5·00	19·8	
20th Jan. 1934	9.2	36·7	4·00	..	..	25·4	
26th Feb. 1934	8·2	32·2	3·94	50·20	..	29·0	

Centenaries in March 1936.

Foster Michael, 1836-1907.

EIGHTH of March 1836, saw the birth at Huntingdon of one to whom Thomas Henry Huxley wrote in 1891 "You are physiologically omniscient." At School and at College Michael Foster distinguished himself in Classics. But coming of a Nonconformist family, he could not get admission into Cambridge for further pursuit of Classics. Hence, he entered the medical side of the University College of London in 1854. Having obtained the M.D. Degree in 1859 and after a year's further work in Paris, he commenced practice with his father at Huntingdon. For six years he remained in practice. But his real longing was for a scientific career. Hence, he gave up practice in 1867 and began to assist his old Professor at the University College in teaching practical physiology. He soon got a reputation as a successful teacher and two years later he succeeded Huxley as Fullerian Professor of Physiology at the Royal Institution.

HIS OPPORTUNITY.

When the University of Cambridge sought the help of Huxley to organise separate teaching in Physiology, he wrote "I know the very man for you, a young fellow at the University College called Foster." This brought the right man to the right place in 1870. Having continued as Trinity Praelector of Physiology for several years, he was elected the first Professor of Physiology of the University in 1883. He continued as Professor till 1903, when he resigned his post. During this period, he created the Biological School of Cambridge. From the first he insisted on practical work and had the biological laboratory built in 1878.

HIS SERVICES TO PHYSIOLOGY.

Before Foster's days, the science of Physiology was scarcely recognised. But Foster's teaching was a revelation; it was all new, not to be found in any English text-book, all so suggestive, opening out vistas of research, showing how little was known, and how much remained to be found out. His enthusiasm and sympathy caused many of the small band of his earliest students to take up a scientific career. He had a marvellous gift to sense the most appropriate field of research for each of his students. For example, when F. M. Balfour was uncertain what line of research to follow, Foster took up an egg, cracked it, showed him the embryo inside and said, "What do you think of working at that?" It is a matter of history how much the science of embryology benefited by this stimulation. The two huge tomes of *Comparative Embryology* of Balfour should have fertilised at that moment. Langley, Gaskell, Sherrington, Sedgewick, Hopkins and Martin are some of the other well-known scientists who were thus shaped by him. In about fifteen years, his influence succeeded in obtaining University recognition for physiology as one on a par with the older studies of the place.

The foundation of the Physiological Society in 1875 was mainly due to him. The *Journal of Physiology*, which started its career in 1878, was another result of his unbounded enthusiasm for his subject. So also it was chiefly through him that the International Congress of Physiologists came into existence in 1889. His popularity was so great that he was elected perpetual Honorary President of the Congress in 1901, with prolonged outburst of applause that seemed as though it would never stop.

But perhaps his most widely known physiological gift was his famous *Text-book* which was published in 1876. It went through eight editions. It was *the* text-book throughout the English speaking world and it was translated into Italian, German and Russian.

HIS SERVICES TO SCIENCE IN GENERAL.

As Secretary of the Royal Society from 1881 to 1903, he set himself to aid Scientific progress in every direction. He took an active part in the establishment of the National Physical Laboratory, in the reorganisation of the Meteorological Office and in the founding of the International Congress of Geodesy. He succeeded in making the Royal Society an expert adviser to a number of Government Departments and a living factor in the life of the nation. He also threw himself heart and soul in the starting of the *International Catalogue of Scientific Papers*. He was a champion of science in the House of Commons, in which he represented the University of London from 1900 to 1906. He served also in several Parliamentary Commissions and was President of the British Association in 1899.

HIS PERSONALITY.

According to *Nature*, no description can do justice to Foster's personal charm. His strongest point was force of character,

energy, perseverance and thoroughness. Foster's actual additions to knowledge by way of research are small. But he was a discoverer of men rather than of theories. His powers of organisation were remarkable. Huxley's estimate of his powers can be inferred from a letter he wrote to Professor Weldon on February 9, 1893, in reply to Weldon's plea that what was possible in the Cambridge Biological School should not be difficult to be achieved in London. He wrote 'Michael Fosters do not grow on every bush."

Foster was a delightful companion. He was excellent as an after-dinner speaker and was usually expected to speak; on the very day on which he died, January 28, 1907, he had made an excellent speech at the meeting of the British Science Guild.

S. R. RANGANATHAN.

Russell (Henry Chamberlaine) 1836-1907.

RUSSELL, the pioneer Meteorologist of Australia, was born at West Maitland, New South Wales, on 17th March 1836, that is, within nine days of the birth of the pioneer physiologist of the British Empire. After graduating at Sydney University in 1858, he became assistant to Mr. Scott, the Government Astronomer and succeeded him in 1870. He held the post for thirty-five years.

HIS CONTRIBUTIONS TO ASTRONOMY.

Apart from reorganising and refurnishing his observatory, he led the Australian observation of the transit of Venus in 1874. He also interested himself in the measurement of Double Stars from 1882 to 1889. Volumes 42 and 55 of the *Monthly Notices* contain his account of the "Transits of Mercury in 1881 and 1894".

HIS CONTRIBUTIONS TO METEOROLOGY.

The chief contribution of Russell was to the Meteorology of Australia. In 1870 there were only 12 meteorological stations in New South Wales and Government could not afford any large outlay towards an increase. But, by his persuasion and influence, Russell induced the farmers to make observations and supplied them with the necessary apparatus made by himself. The result was that, when he resigned his post in 1903, there were 1800 stations, of which over 1500 were voluntary.

By 1878, he began to get a sufficient number of returns from the observation stations, and he commenced the publication of weather map in the papers. He also succeeded in establishing a system of weather forecast. It is said that 82 per cent. of his forecasts were found to be correct.

As an inventer, there are 23 meteorological instruments to his credit. He contributed 130 papers to various learned periodicals.

HIS GENERAL SERVICES.

Mr. Russell took a very active part in initiating technical education in Australia and was a member of the Board of Technical Education. In 1891 he was made Vice-Chancellor of the University of Sydney. He was for several years President of the Royal Society of New South Wales. He was the first New South Wales man to be elected an F. R. S. This was in 1886; while he became a Fellow of the Royal Astronomical Society in 1871.

After a severe illness in 1903, when he retired from service, his health continued to be indifferent, until he died on February 22, 1907.

S. R. RANGANATHAN.

The Total Solar Eclipse of June 19, 1936.

THE Governments of Soviet Russia and Japan have invited the various scientific organisations of the world to send expeditions to their territories for observation of the eclipse. Since the eclipse of February 1934, this is the first total solar eclipse to be visible on the earth. According to the *Christian Science Monitor* (January 2, 1936) the eclipse will begin to be visible at sunrise in the Mediterranean Sea off the south-western coast of the Grecian Peleponnesus. The moon's shadow, making a path of totality about 50 miles wide, will sweep in a direction north of east across the Ægean Sea, Istanbul and the Black Sea and will pass south of Rostov and Stalingrad, across Orenburg and over Omsk and Tomsk in Siberia.

An expedition consisting of six scientists from Georgetown University and the National Geographical Society, under the leadership of Dr. Paul A. McNally, Director of Georgetown College Observatory, will leave America in April to take photographs during the two and a half minute total eclipse. It is announced that the headquarters of the expedition will be established near Orenburg, 775 miles south-east of Moscow, over which the centre of the moon's shadow will travel during the eclipse.

Letters to the Editor.

CONTENTS.

The Spectrum of SiF.

IN connection with a forthcoming paper by us on the bond energies of molecules, we found that the existing analysis of SiF bands was by no means complete and satisfactory.[1] We have therefore revised the vibrational analysis of the β-bands and of the α-bands, and added an analysis of the γ-bands. The β-bands can now be ascribed to $^2\Sigma \rightarrow {}^2\Pi$, the α-bands to $^2\Pi \rightarrow {}^2\Pi$ and the γ-bands to another $^2\Sigma \rightarrow {}^2\Pi$ transitions. All these transitions involve the same $^2\Pi$ lower level which is also the ground state of the molecule. The constants of the molecule in its various electronic states are :—

Term	ν_0 (cm.$^{-1}$)	ω_0	$\omega_0 x_0$	D(Volts)
X $^2\Sigma$	0 161·1	852·0	4·7	4·77
A $^2\Pi$	23573·9 448·4	674·4	6·9	2·04
B $^2\Sigma$	34716·6	1006·4	4·8	6·51
C $^2\Sigma$	39531·5	885·5	6·2	3·90

A detailed report of the analysis and the structure of the molecule will be published elsewhere.

R. K. ASUNDI.
R. SAMUEL.

Department of Physics,
Muslim University,
Aligarh,
March 14, 1936.

[1] *Cf.* Jevons: *Report*.

Hydration and Change in Water Equilibrium in Electrolytic Solutions.

IN continuation of my previous work[1] on the subject, the three strong electrolytes, sodium nitrate, sulphuric and hydrochloric acids, are now studied in their aqueous solutions along with the pure solvent in each case under identical experimental conditions and with times of exposure varying inversely as the quantity of water contained in equal volumes of the solution and the pure solvent with a view to quantitatively estimate the changes that take place in the constitution of water *as solvent* as compared with that of the pure liquid.

It has been found from my earlier investigations that the influence of strong electrolytes on the constitution of water is to shift the water equilibrium between mono-, di- and tri-hydrol as could be inferred from a detailed study of the structure of the Raman water-band in their aqueous solutions. Further, in most of them, the observed effect has been noticed to be complicated by the presence of hydration, which has been found to be least prominent in the case of sodium nitrate. The influence of mono-, di- and tri- or more complex hydrates on the structure of the Raman water-band has been shown elsewhere[2] to be to intensify approximately the corresponding components of the water-band due to the single, double and triple molecules of water. With a view to supplement the qualitative results hitherto obtained in a number of substances, a quantitative study of some of them is undertaken in the present investigation.

For this purpose, analysis of the intensity curves of the Raman band for water in the pure solvent and in the solution is carried out for each of the electrolytes on the lines of the analysis made by Ramakrishna Rao,[3] with the following results :—

Substance	Percentage proportion of		
	$(H_2O)_1$	$(H_2O)_2$	$(H_2O)_3$
	%	%	%
I. (*a*) Water	13·35	56·2	30·45
(*b*) $NaNO_3$, 8N	27·74	56·4	15·86
II. (*a*) Water	13·52	56·15	30·33
(*b*) H_2SO_4, 7·81N	16·97	50·5	32·53
III. (*a*) Water	13·7	55·3	31·0
(*b*) HCl, 7·65N	11·04	69·39	19·56

In the light of the above analysis, the influence of each of the dissolved electrolytes appears to be as follows: while sodium nitrate tends to change trihydrol into monohydrol with no especial effect on the proportion of dihydrol, hydrochloric and sulphuric acids tend to change trihydrol into dihydrol and dihydrol into mono- and trihydrol respectively. Further, in the case of the acids, the observed changes in the distribution of intensity along the water-band also partly arise out of the presence of hydration of the ions of the dissolved substances: thus, while hydrates with two molecules of water of hydration preponderate in the solution of hydrochloric acid, those with one and three or more associated water molecules appear to be present in greater numbers in the solution of sulphuric acid at the same concentration.

A detailed report of the investigation will appear elsewhere.

C. SAMBASIVA RAO.

Andhra University,
Waltair,
February 1, 1936.

[1] *Curr. Sci.*, 1934, **3**, 154; *Ind. Jour. Phys.*, 1934, **9**, 195.
[2] *Proc. Roy. Soc.*, (A), 1935, **151**, 167.
[3] *Proc. Roy. Soc.*, (A), 1934, **145**, 489.

Constitution of Formic Acid and Formates.

IN a recent issue of the *Journal of the Indian Chemical Society* Halasyam[1] points out that the calculated parachor value for the Sarkar-Ray formula[2] for formic acid is in better agreement with the experimental value than that of the dihydroxymethylene formula of Seshadri.[3] He advocates therefore the acceptance of the first formula. He omits, however, to point out that the calculated parachor for the usual formula for formic acid (93·2 units) also agrees with the experimental value (93·3)[4]. The parachor values cannot therefore be employed to support the Sarkar-Ray formula.

T. S. WHEELER.

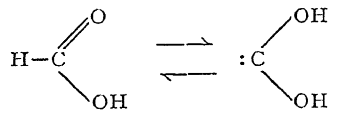
Royal Institute of Science,
Bombay,
February 27, 1936.

[1] *J. Ind. Chem. Soc.*, 1925, **12**, 813.
[2] *Proc. Ind. Science Congress*, 1935, 109.
[3] *Curr. Sci.*, 1934, **3**, 353.
[4] See Landolt-Bormstein, 2nd Supplement, 5th Edition, p. 177.

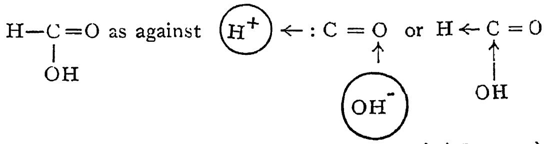
On the Constitution of Formic Acid and Formates.

IN the December, 1935, issue of the *Journal of the Indian Chemical Society* (p. 813) received just now, there is a note by Halasyam on the above subject. Referring to my letter to *Current Science*, under the same title 1934, **3**, 353, he writes, "The labile structure is more in the nature of a zealous endeavour to save the classical formulæ of organic chemistry from the ruthless onslaughts of the modern physical chemist with his searching X-ray and spectroscopic analysis. It is probably once again this fervour which actuated the statement, etc." Such remarks are out of place in a scientific controversy.

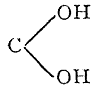
Halasyam says, "Seshadri disagrees with this view and postulates in its place a labile structure to the acid molecule,

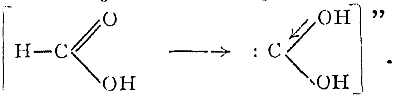


which is apparently meant to do away with the heterodox hypothesis of Ray and Sarkar and yet explain the absence of the well-known Raman line." I would suggest a more careful perusal of my previous letter to *Current Science*. I maintained and still maintain that formic acid has the simple rational constitution



(Ray and Sarkar) (Halasyam)

It was never suggested that free formic acid has the structure :  . The relevant portion of my letter is, "In my opinion the exceptional properties of formic acid are due to the fact that in it the carboxyl is linked to a hydrogen atom whereas in its homologues the carboxyl is linked to alkyl groups and that *in the course of certain of its reactions formic acid is capable of undergoing isomeric change* into dihydroxymethylene.


"

Hence there seems to be no justification for Halasyam's remarks on basicity and parachor. There is again mention in his note of "unequivocal evidence from Raman spectra and Isomorphism of Formates and Nitrites" to support the new structure. I would refer him in this connection to Venkateswaran's paper,[1] which was published about the end of the same month to show that Raman spectrum evidence is decidedly against it. This question was not raised in my previous letter since it was felt that it required careful investigation which was being arranged for. Regarding isomorphism, I consider that the point is still to be established. A detailed discussion will be taken up later on.

T. R. SESHADRI.

Chemistry Department,
J. V. D. College of Science and Technology,
Andhra University,
Waltair,
February 13, 1936.

[1] *Proc. Ind. Acad. Sci.*, 1935, 2, 615.

IT is admitted by Seshadri that formic acid with "the simple rational constitution, in the course of certain reactions, is capable of undergoing isomeric change into dihydroxy methylene." If this does not mean a labile structure, I wonder what constitutes one. Venkateswaran in the paper referred to by Seshadri suggests that the Raman line 1534 cm.$^{-1}$ observed in the case of lead-formate may be due to the possible dihydroxymethylene structure proposed by the latter. Although this is not the place to enter into a discussion of the case, as a Raman line 1542 cm.$^{-1}$ is given by sodium acetate[1] the origin of this line is a matter of much uncertainty.

Further, the evidence adduced by Venkateswaran from Raman spectra in support of the classical formula for formic acid is by no means conclusive. The 2930 (strictly the 2960) line of the C-H linkage is likewise absent in his spectrograms; instead, the lines 2834 and 2732 are attributed to this linkage. Whether such a large shift, from 2960–2834, is normal in salt formation is uncertain. On the analogy of the higher homologues, acetic and propionic acids and the substituted chloracetic acid and their metallic salts, where salt formation does not shift the line by more than a few wave-numbers,[2] one is more inclined to imagine a rupture of the C-H linkage in the formates.

It is a matter of deep regret that Seshadri does not "consider that formates and nitrites are" isomorphous, in the face of mixed crystal formation in these salts, cited by Sarkar and Ray.[3] Either Seshadri disbelieves the work of these authors, or he is unable to throw away the shackles of age-long tradition.

R. M. HALASYAM.

3, Y. M. I. A.,
Armenian Street,
Madras,
March 9, 1936.

[1] *Cf.* Edsall, *J. Chem. Phys.*, Jan. 1936, 1.
[2] Edsall, *loc. cit.*
[3] *Proc. Ind. Sci. Congress*, 1935, p. 109.

The Non-Protein Nitrogen of Pulses.

IN a previous communication[1] attention was directed to the dietary significance of the easily assimilable non-protein nitrogen fraction occurring in appreciable percentages in some of the pulses. A study of the amino acid make-up of the fraction is important not only from the view-point of its nutritive value but also from the standpoint of its physiological relationship with the proteins of the pulse. The non-protein nitrogen of the three well-known pulses, *P. aconitifolius*, *Cicer arietinum*, *P. mungo*, has now been partitioned by the method of Van Slyke as modified by Damodaran[2] so as to include the dicarboxylic acid nitrogen. An independent estimation of arginine by arginase has also been carried out.

TABLE I.

	Percentages of Total Nitrogen		
	P. aconitifolius	*Cicer arietinum*	*P. mungo*
Melanin N ..	1·24	2·34	2·37
Amide N ..	5·54	6·11	3·41
Dicarboxylic N ..	23·72	13·08	16·18
Non-basic N			
Amino N ..	25·76	19·31	19·95
Non-amino N ..	0·51	0·04	16·52
Basic N			
Amino N ..	20·56	15·22	11·21
Non-amino N ..	24·98	44·29	32·46
	102·31	100·39	102·10
Arginine (Van Slyke)	12·71	45·48	34·59
,, (enzyme) ..	8·59	22·92	16·30

A close study of the results in Table I will reveal important differences in the composition of the non-protein nitrogen fraction, emphasising the widely differing dietary values so well recognised in actual practice. *P. aconitifolius* has a very much higher percentage of dicarboxylic nitrogen while in the case of *P. mungo*, the value for the non-basic non-amino nitrogen points to the existence of proline in exceptionally high concentration.

The percentages of the amino nitrogen in the basic fraction of *Cicer arietinum* and *P. mungo*, are low, while their arginine contents as determined by Van Slyke's method are high; further distinctly lower values for arginine are however obtained by the enzyme method which points to the presence of bases other than arginine, capable of easily yielding ammonia during alkali hydrolysis. The bases appear to possess no free amino group capable of reacting with nitrous acid, as revealed by the low values for amino nitrogen in the basic fraction. Further work with a view to characterise these bases, is now in progress.

KAMALA BHAGVAT.
M. SREENIVASAYA.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
March 7, 1936.

[1] *Curr. Sci.*, 1935, **3**, 354; *Biochem. J.*, 1935, **29**, 909.
[2] *Biochem. J.*, 1931, **25**, 2123.

A Note on the Melting Point of Cane Sugar.

SUCROSE is one of the very well-known and common substances and that makes it the more surprising when the readily available different text-books record an uniformly incorrect figure as its melting point, *viz.*, 160° C. The accompanying list will show that even the standard or authoritative sources (the last four) do not agree among themselves.

While trying to identify an unknown sugar m.p. 182° C., we suspected it to be cane sugar. But on reference to some text-books, the melting point of cane sugar was found to be 160° C. Hence the possibility of our sugar being cane sugar was thought to be remote. However, on taking the melting point of bazaar cane sugar, it was found to be 182° C. On taking a mixed melting point of the bazaar sugar with our sugar, no depression was observed. On repeated recrystallisation from alcohol and desiccation over phosphorous pentoxide, the bazaar sugar melted at 188° C.

Author	Book	m.p.
Holleman	Lehrbuch der Organischen Chemie	160°
Cohen	Theoretical Organic Chemistry	160°–61°
Bernthsen	A Text-Book of Organic Chemistry	160°
Diels	Einfuehrung in die organische Chemie	160°
Heriot	Manufacture of Sugar from the Cane and Beet	160°
Jagindarsingh	A Text-Book of Organic Chemistry	160°
Weston	Carbon compounds	160°
Clarke	A Handbook of Organic Analysis, Qualitative and Quantitative	160°
Richter	Lexicon der Kohlenstoffverbindungen	160°
Kaye and Laby	Physical and Chemical Constants	189°
Beilstein	Handbuch der organischen Chemie	160° (Berzelius) 180° (Peligot)
Thorpe	Dictionary of Applied Chemistry	185°–86°

It was thought possible that previous workers got the m.p. 160° C. because of slow heating and consequent partial decomposition into glucose (m.p. 146° C.) and fructozone or even partial hydrolysis into glucose and fructose due to the presence of traces of water. Hence in one case as soon as the temperature 160° C. was reached,

it was kept constant for five minutes without the cane sugar showing any signs of melting; on raising the temperature further, it finally melted at 188° C. sharp.

A reference to a paper "The Melting Point of Sugar" by K. Sundera and A. Mircev[1] is here necessary. These authors determined the melting point of various sugars and found that the method of making the determination had a very great influence on the melting point; the difference may amount to as much as 25° C. in some cases. To see whether the same was true in the case of cane sugar, we determined its melting point under the following varying conditions:

(1) Keeping the tube in the bath from the beginning and heating it gradually to 188° C., total amount of time taken to raise the temperature from 150° C. to 188° C. being six minutes.

(2) Immersing the tube at 150° C. and then raising the temperature gradually to 188° C., stopping at 160° C. for five minutes, total time being seven minutes.

(3) Immersing the tube at 180° C. and then raising the temperature gradually to 188° C. stopping at 184° C. for two minutes, total time being four minutes.

The melting point found by us in all the above cases was 188° C. When the velocity of the rise of temperature was strictly maintained at 1 minute for ½° C., as recommended by Sundera and Mircev, in some cases there was softening at 184° C. though the sugar melted finally at 188° C.

This shows that the melting point of sucrose is independent of the variables, the total time of heating, the velocity with which the temperature of the sample is raised or the temperature of the surrounding bath and that it depends upon the purity of the sample alone.

S. V. SHAH.
Y. M. CHAKRADEO.

Rajaram College,
Kolhapur.
February 15, 1936.

[1] *Zeit. Zuckerind. Czech. Rep.*, 1934–35, **59**, No. 23, 204–206.

The Iso-Electric Point of Vitamin B_1.

IN a note on the iso-electric point of vitamin B_1, appearing in the February number of *Current Science* (p. 586), Mr. G. Narasimhamurti makes the following statements.—"Sankaran and De reported that the iso-electric point is in the acid range (pH 3·0) while Guha and his collaborators found it to be in the alkaline range at pH 8·5. These discordant results may be ascribed to the use of impure vitamin B_1 preparations; further, the values obtained were not confirmed by satisfactory biological tests." There are certain inaccuracies in these statements, which should be corrected. Firstly, Birch and Guha[1] did not state that the iso-electric point was at pH 8·5. They concluded from their experiments on concentrated yeast extracts that "vitamin B_1, behaves like a base even at pH 8·5, and, therefore, must be either a true base or an ampholyte whose iso-electric point is higher than pH 8·5." This conclusion was confirmed by Ghosh and Guha,[2] who found that the vitamin in a very concentrated fraction obtained from rice-polishings also migrated to the kathode at pH 8·2. We did not consider it worthwhile pursuing this question further and it was taken up only in view of Sankaran and De's observations. Secondly, some of the vitamin preparations used by us, although not pure, were highly concentrated and our results were invariably based on "satisfactory" biological tests carried out according to well-known standardised techniques and we had pointed out that Sankaran and De were perhaps misled by their reliance on chemical assay only. Mr. Narasimhamurti's present observations substantially confirming our earlier results are, however, to be welcomed.

B. C. GUHA.

Indian Institute for Medical Research,
Calcutta.
March 6, 1936.

[1] *Biochem. J.*, 1931, **25**, 1391.
[2] *Curr. Sci.*, 1935, **3**, 554.

Preliminary Note on the Blood Groups of Some Cochin Castes.

AGGLUTINATION tests have been made upon out-patients at the General Hospital, Ernakulam, Cochin State, South India, with the co-operation of Dr. P. Narayan Menon. Test sera were obtained from the Haffkine Institute, Bombay, through the courtesy of the Director, upon the recommendation of

Professor R. R. Gates, F.R.S. The method followed was that given by Kolmer and Boener in *Approved Laboratory Technic.* Blood was taken from patients belonging to seventeen different communities; 300 blood samples were tested by the writer and 300 by Dr. Menon. The data for some important castes already reveal characteristics of sufficient interest to be recorded now, although we hope to obtain more. The data for a small sample of Tamils, which were obtained from various non-Brahmin castes are also given in the following table for comparison with the West Coast people:—

TABLE I.

Cochin Blood Groups by Castes (1935).

Caste and No. of subjects	Numbers belonging to groups			
	O	A	B	AB
Naiars—121	47 (*38·8%*)	43 (*35·5%*)	27 (*22·4%*)	4 (*3·3%*)
Syrian Christians—140	51 (*36·4%*)	37 (*26·4%*)	40 (*28·6%*)	12 (*8·6%*)
Izhuvans—132	77 (*58·3%*)	32 (*24·2%*)	16 (*12·2%*)	7 (*5·3%*)
Pre-Dravidian Tribes—50	26 (*48%*)	13 (*30%*)	6 (*9%*)	5 (*12%*)
Tamil Non-Brahmins—50 (Madras)	21 (*42%*)	14 (*28%*)	12 (*24%*)	3 (*6%*)

The Naiars are a mixed race from an original Dravidian (Melanid) stock now intermixed with Nambuthiri Brahmin genes.[1] They are a matriarchal community and high caste Naiars often have Brahmin fathers. The Syrian Christians are descended from Brahmins and Naiars who were converted to Christianity early in the Christian Era, perhaps about 300 A.D. These data show a higher proportion of B, the group of North India, among them than among the Naiars. Although this may be due to the size of the samples it will only be possible to judge the relative heterozygosity of these two communities after sufficient data have been obtained from Nambuthiris for comparison. The Dravidian group A is well represented in them both.

The Izhavans are a Dravidian caste who probably came to the Malabar Coast from Ceylon,[1] and they show a very low percentage of group B. A sample of only twenty-five of the Dravidian fisherman caste, Valans, indicates that they also have very little B. The Dravidian data from both coasts, although from small samples, are of interest because of the strong resemblance they bear to those of Heydon and Murphey for Melanesian Papuans (53·7% O, 26·8% A, 16·3% B, 3·2% AB),[2] as well as those of Bijlmer[2] for some tribes of the Halmaheira Islands of the Moluccas; a similarity that warrants further investigation. The consistently high proportion of Group I that we find among the lowest castes of Cochin indicates that they belong to a very ancient stock. The proportion of Group B is lower in the high caste non-Brahmins of Cochin than it is further north where B exceeds A. This is probably due to the original scarcity of agglutinogen B among the Pre-Dravidian and Dravidian people in South India.

Only fifty members of Pre-Dravidian tribes have been examined at Ernakulam. The data for these agree with those of other workers for primitive races in showing a low percentage of B, fairly high A and about half the population in Group O lacking both agglutinogens.

EILEEN J. W. MACFARLANE.

Madras,
March 1, 1936.

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[1] Ayyar, L. K. Ananthakrishna, *The Cochin Tribes and Castes*, Ernakulam.

[2] Bijlmer, H. J. T., *Journ. Roy. Anth. Inst.*, 1935, **65**, 123-131.

Chromosome Numbers in *Millingtonia hortensis*, Linn. f. (Family: *Bignoniaceæ*).

Millingtonia hortensis, the Indian cork tree, a native of Burma and Malay Archipelago, is extensively planted in avenues and gardens in India. The chromosome numbers have been, for the first time, determined by the author. Several counts were made in the metaphase plates of somatic and meiotic mitosis. The $2n$ number of chromosomes is 30 and the n number is 15.

U. NARASINGA RAO.

Oil Seeds Section,
Agricultural Research Institute,
Coimbatore.
February 25, 1936.

Mathematics and the Sciences.

I AM grateful to your reviewer for so freely quoting (p. 591) examples from *Descriptive Mathematics*. To these I shall refer in reverse order. The example on rhythm in prose I cannot take space here to explain; I would merely extend it by putting the question, whether there be in any language a group of words or syllables, other than the specific "tra la la", which do for three-time in music what "due, duty, dutifully" do for four-time. The example is evidently a "wandering away from well-trodden paths" on which the reviewer frowns.

The excuse for the example on the secant is that the speed with which the sun crosses the horizon is noticed at once by one who comes to the tropics, and it is the contrast with the insensibly slow speed in temperate latitudes that is suggested. Build on this astronomy if you will, but the example itself is based on a wide range of simple experience.

The quotation of Vieta's formula (*Descriptive Mathematics* 12, Ex. 8) is, I am afraid, divorced from its context, "calculate as far as the slide rule allows .... Compare with this....logarithms." There is nothing really terrifying about the calculations; the limitations of our tools are soon revealed! The other examples with the astronomical numbers are, for one thing, intended to deliver from the general fear of such numbers. It comes as a great relief to the students to see the ease of dealing with such examples from a commonsense point of view. I have found nothing to equal the slide rule as a means of teaching students commonsense. (Must I take the phrase "all the slide rules in the World" to be a response to my query as to discussions on slide rules?)

It may be useful if, following your reviewer's example, I mention a personal detail. I have no liking for statistical work, and I do none save what the students may require; I have often wondered if it be a disadvantage that I have had no intimate experience of computing.

(i) More important, however, than such matters is the suggestion advanced that the present courses in mathematics are really satisfactory, with the implied denial that there is any special need to make liaison between mathematics and the sciences. Doubtless there are somewhat rare scientific workers who "automatically cultivate the required speed and accuracy in numerical work", but the general experience is that great numbers are handicapped, and that even books and researches in their subjects are practically closed to them, because they had been given a mathematical training of an unsuitable kind. One aim I should like to do something to achieve is to make such books as Barcroft's *Architecture of Physiological Function*, or A. V. Hill's books and papers, easy reading for the physiologist, and Keynes' *Money*, Vol. I, for the economist. Nine-point circles and factorizations give no aid here; their beauty must be reserved for specialist students.

(ii) As to what is teachable, it was actually the fact that we mathematical teachers generally fail to convey to our students anything more than the impression that we are dealing with interesting puzzles that started me on the investigation which has led at this stage to *Descriptive Mathematics*. The complaint made is that I have overloaded the course, and to the outsider it will certainly appear so. What, I believe, led the Board of Studies in Bombay University to arrange full facilities for teaching this course was that I gave the members of the Board every opportunity to inspect the actual work of the students and to question them personally. It *is* possible to give students the satisfaction of *Power* with regard to the mathematical operations in question: at the very least they are frequently in a position to apply critical tests to assertions which with the customary training they would have had to accept open-mouthed, '*Experto crede!*', and I am not alone in the Bombay Presidency in having tested this new approach.

JOHN MACLEAN.

Wilson College,
Bombay,
March 9, 1936.

I AM unwilling to continue the controversy, on the subject; I shall close with a few remarks. In the first place, I have been put at ease by Prof. Maclean's nearly frank statement about his "wandering away", and about his recording through an example one of his experiences as he came over to India from northern latitudes.

Prof. Maclean refers to "the suggestion advanced that the present courses in

Mathematics are really satisfactory". Wherever this suggestion may have come to him from, I am surely not its author or supporter. But in my opinion, the present book goes no way to remedy the defects of the existing system. The author aims at teaching the first year Intermediate students the elementary principles of mathematics and at the same time "deliver" them "from the general fear" of "astronomical numbers". I wish the author all success in the attempt but unless the Bombay Presidency students are, as human beings, made of some other material than their colleagues elsewhere, I can foresee only a very limited amount of success in the endeavour.

"Nine-point circles and factorizations. ... ; their beauty must be reserved for specialised students"—so writes Prof. Maclean, though I made no reference to these. But in the question papers set at the Wilson College, the non-specialised students are asked (i) to discuss the difficulty caused by irrational numbers in the theory of similar figures, (ii) to prove that any portion of an equiangular spiral is similar in form to any other portion within the same angular range, (iii) to evaluate a fourth-order determinant, etc., etc.

Mathematicians ! Please don't be "Conservative" or "narrow-minded" !!

I shall close with the following sentence of Prof. Maclean, which, I trust, will amuse the general scientist, the student of Arts and the general educationst :

"I have found nothing to equal the slide rule as a means of teaching students commonsense."

C. N. S.

A Modification of Dixon's Constant Pressure Respirometer.

By Dr. B. N. Singh,

Agricultural Research Institute, Benares Hindu University.

PRACTICALLY all methods of determining the respiratory exchange in plants depend upon the use of some gas-analysis apparatus, the one devised by Haldane being usually employed. Gas-analysis is a tedious process and various investigators have felt the need of some simpler method. In the course of investigations on the influence of temperature on gaseous exchange in *Pisum sativum*, a study designed primarily to get an insight into the reactions involved in respiration,[1] the constant-pressure respirometer recently described by Dixon[2] was found to be highly convenient for respiration measurements. But it was found in practice that the temperature of the measuring pipette in the Dixon's respirometer frequently changes, thus introducing considerable errors. To obviate this difficulty, a "compensation" pipette (B′) has been added to the Dixon's apparatus (Fig. 1). As a further safeguard against temperature fluctuations, the graduated pipette (B), the compensation pipette (B′) and the manometer (M) have been enclosed within a glass jacket, the water in which is kept stirred to maintain a uniform temperature. The addition of the water jacket introduces no inconvenience manipulation as the respirometer need not be shaken during experimentation. The 3-way tap (F) facilitates the introduction of the monometric liquid (paraffin coloured with Sudan III) into the U-tube (M). The vessels P and Q are of the type used by Haines (see Fraymouth[3]) in the modification of the microrespirometer of Barcroft and Winterstein. Arising from the base of each vessel is a capillary tube which communicates with the outside air and may be closed by means of a tap (T). The right-hand vessel contains a glass-lattice platform on which the plant material is placed.

Attention has recently been drawn by various investigators to the existence of several metabolic groups among individuals of the same chronological age, an important consideration when it is not feasible to experiment upon single individuals. In investigations where a number of seeds are taken in a lot for experimentation, this error is considerably reduced, if not entirely eliminated, by a rigid control over the selection of a single variety and the conditions of germination in order to obtain a population more or less of the same meta-

[1] Crozier, W. J., *J. Gen. Physiol.*, 1924, **7**, 123.

[2] Dixon, M., *Monometric Methods*, 1934 (Cambridge).

[3] Fraymouth, *J. Ann. Bot.*, 1928, **42**, 75.

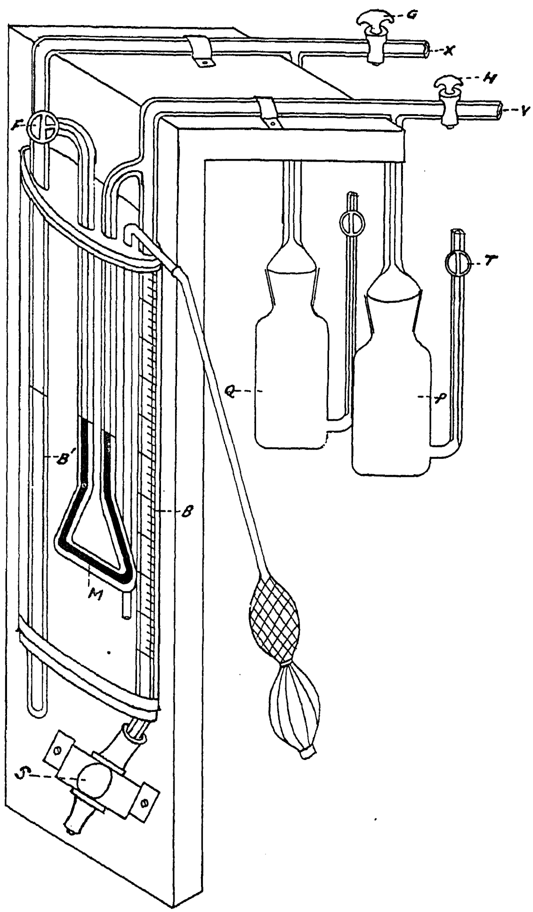

Fig. 1.

Modified Dixon's Respirometer.

bolic age. After the germinating seeds have been weighed they are placed in the right-hand vessel, 20–25 minutes being allowed for the vessels to attain the temperature of the water bath. This long period of equilibration is necessary as the material takes an appreciable time before the constant rate of respiration for the temperature of the apparatus is reached. Moreover, when seeds are brought from a lower to a higher temperature the output of CO_2 is temporarily increased (due, in all probability, to the lower solubility of CO_2 at the higher temperature) above the level that it subsequently attains at that temperature.

Further details of manipulation are as follows. In order to fill the vessels with dry CO_2-free air the supply tube is connected by means of a T-piece with the tubes (X) and (Y) and the air is allowed to escape through the side-tubes attached to the vessels, after 3–4 minutes the current being stopped, the outlets closed and the supply tube detached. By means of the screw (S) the mercury is adjusted to the mid-point on the graduated 1 c.c. pipette (B) and the taps G and H are closed. After 45 minutes the reading of the pipette, representing the resultant of oxygen absorption and CO_2 evolution is noted and the taps G and H are opened. Having introduced a piece of damp potash in each vessel, both the vessels are filled with CO_2-free air in the usual fashion. In this case the CO_2 produced is absorbed by the alkali, the oxygen uptake being noted after 45 minutes. Let us assume that the volumes involved due to oxygen absorption and CO_2 evolution are $V\ O_2$ and $V\ CO_2$ respectively. The volume V read after the first 45 minutes gives the algebraic sum (the readings are considered + ve or − ve according as they indicate an evolution or absorption of gas) of $V\ O_2$ and $V\ CO_2$:

$$V = V\ CO_2 + V\ O_2$$

$$\text{or } V\ CO_2 = V - V\ O_2$$

$$\text{whence R.Q.} = \frac{V - V\ O_2}{V\ O_2}$$

A few values of R.Q. obtained for *Pisum sativum* with the apparatus are tabulated below:

Stage in germination	Temperature		
	25° C.	30° C.	35° C.
1	1·01	1·00	1·02
2	0·62	0·65	0·72
3	0·80	0·82	0·91
4	0·77	0·78	0·80

Measurements of R.Q. were made at four stages during germination, *viz.*, (1) soaked seeds, (2) seedlings with roots 0·4 cm. long, (3) seedlings with roots 4 cm. long, and (4) seedlings with stem 2 cm. long. Generally speaking, an increase in temperature above 25° C. is associated with an increase in the ratio CO_2/O_2.

Pictorial Statistics—A New Method of Teaching.

By Prof. R. Samuel,
Muslim University, Aligarh.

ONE of the greatest difficulties of teaching in our time is the ever-increasing amount of human knowledge and the ever-increasing entanglement of the individual facts produced by the complicated connections of present-day civilisation. The great experiments of a hundred years ago, say Faraday's investigation on the relation of electricity to magnetism, have to be taught to-day in lower classes in order to gain time in the upper ones for teaching the modern developments of science. The teacher of economics, who wants to lecture, say on the world crisis, has to acquaint his audience with the social, economic, hygienic, and historical conditions of each and every continent and country before he can even start to analyse the situation of the times. It is becoming increasingly difficult to keep in touch with different spheres of activity of the civilised man and this has resulted in narrow specialisation of certain branches of knowledge accompanied by stupendous ignorance of others, as is seen not only in different strata of society but in every human being. How many men among us with classical education know our own body, how and why it works? How many scientists and technical men know the history, the social and the economic development of our civilisation, on whose functioning our welfare and happiness depend? Any number of such questions can be put with justification even to the highly educated classes, the specialists themselves. And this state of affairs confronts us everywhere. How, for instance, is a nation supposed to regulate its life, when the individual has lost sight of the basic facts of its existence? But how can knowledge be acquired? Who has the time to study scientific or technical treatises; who is able to read a complicated statistic—and understand its implication? This article is intended to draw attention to a new method of teaching which may be a possible solution for many of the difficulties indicated above.

The *Vienna Method of Pictorial Statistics* was originally developed by Dr. O. Neurath and his collaborators in Vienna, where the municipality wanted to acquaint the people with its activities and to popularise its achievements with a view to obtain their intelligent co-operation. From such a small beginning it has now grown to be a recognised method of teaching on the Continent, in England, and in America.

The idea of representing statistics by pictures is very old. In spite of the fact, that the basic principles of the Vienna method are few and simple—as in so many good methods—the difference between the old way of representation and the new one is enormous. Let us suppose that it is desired to compare the motor car industry of America with that of Europe. The old way would be to represent the American industry by a big car and the European with a small one. So far so good; but now the difficulty arises:—what shall be compared? The height, the length or the area of the picture? In addition to the picture it becomes necessary to indicate the numbers of cars produced in each country. In other words, the illogical position, *viz.*, that the statistics is given in two different manners,—in figures *and* pictures,—is brought out, the latter being degraded to mere illustrations, the former alone giving the real meaning. One of the fundamental principles of the modern method is, to represent the facts, whatever they may be, by a *repetition of pictorial units*, each unit standing for a certain quantity. Fig. 1 gives in this manner a comparative idea of the motor car industry in America and in Europe. Here we see pictures of a number of cars, each of which is meant to represent 100,000 motor vehicles produced. Further the method is particularly adapted, to represent various other facts simultaneously and to indicate their inter-relations. This is done by giving an individual symbol intended to represent the fact, such form and appearance that it is clothed with technical or social meaning, and by arranging these symbols in a suitable manner, they can be made to convey their relationships. Referring to this picture again we see the number of employed workers, each symbol representing the worker, standing for 100,000 employees, and we can see at one glance, that the annual production *per worker* is 11 cars in America and less than 1 car in Europe. The background for the portion of the picture

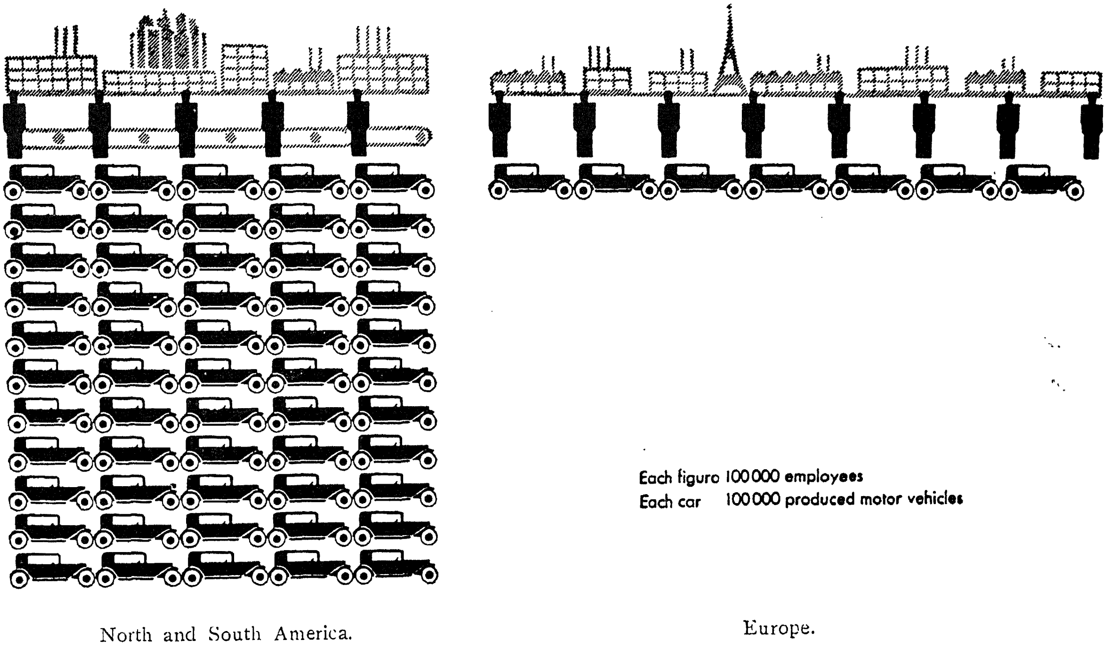

Fig. 1. Production of Motor Vehicles in 1929.

representing America, for instance, the sky-scrapers and the symbols of mass production convey the reason, *viz.*, the higher state of rationalisation, for the high level of the industry in that country.

A similar problem is dealt with in Fig. 2.

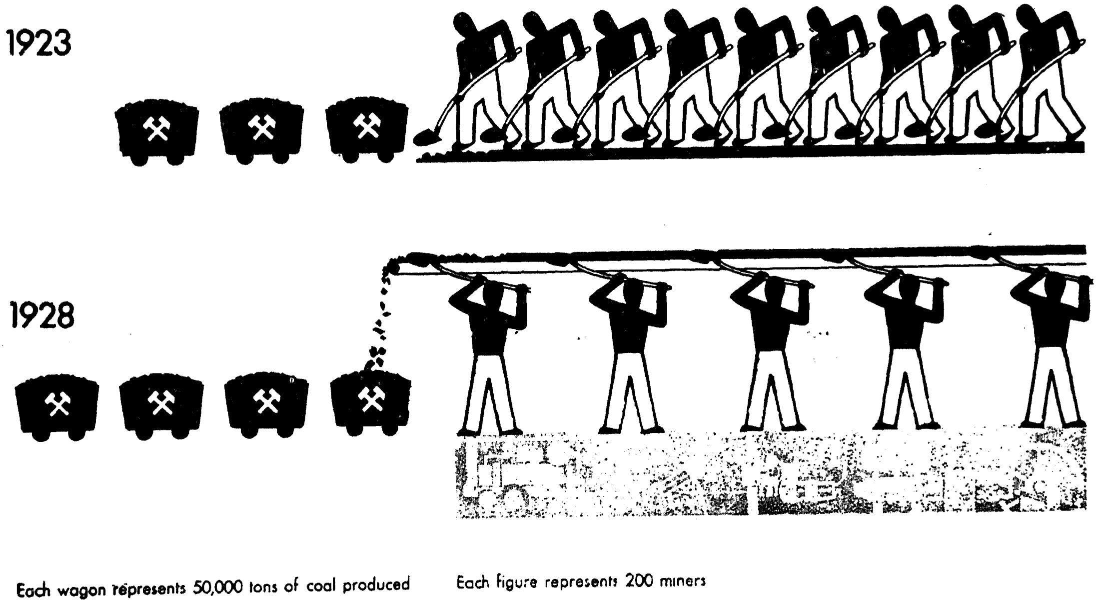

Fig. 2. Rationalization and Reduction in the Number of Workers.

(Rationalization of an Austrian coalmine.)

Here, however, the inter-relation and explanation of the factors thus represented do not constitute a side issue, but form the main object of the representation. We are able to see not only the increased production and reduced number of workers represented, but also the difference between manual and automatic transport clearly portrayed.

Thus, by a careful design of each individual symbol, and by a thoughtful construction of each table, each picture can be made to be a living entity. In short a simplified language results. These modern hieroglyphs speak a language which anyone can understand. Their possible applications are many indeed; they may be employed wherever facts and their relations have to be stated; in other words, they make it possible to "get a picture" at one glance.

Fig. 3 gives an example of the method in science teaching, shows the development of mechanical engineering. The lifting of 350 tons which was done some hundred years ago by 140 horses and 840 men, is accomplished by a crane and 3 men to-day. Fig. 4, an example of the application of the *Vienna Method* to Geography and Economics, shows the productiveness of the continents. Each black figure represents 100 millions of human beings, actually living there, whereas the white figures indicate, how many more millions could be supported on each continent. It can be seen that Europe and East Asia (China) are the really over-crowded parts of the globe, no white figures being present, whereas North America is only sparsely inhabited. In the picture at the same time distinguishing marks are employed to characterise the standard of the economic system of the people, the toothed wheel standing for modern technical method, the hammer for the earlier method and the bow and arrow for the methods of the tribes of primitive hunters.

We have confined ourselves in this article

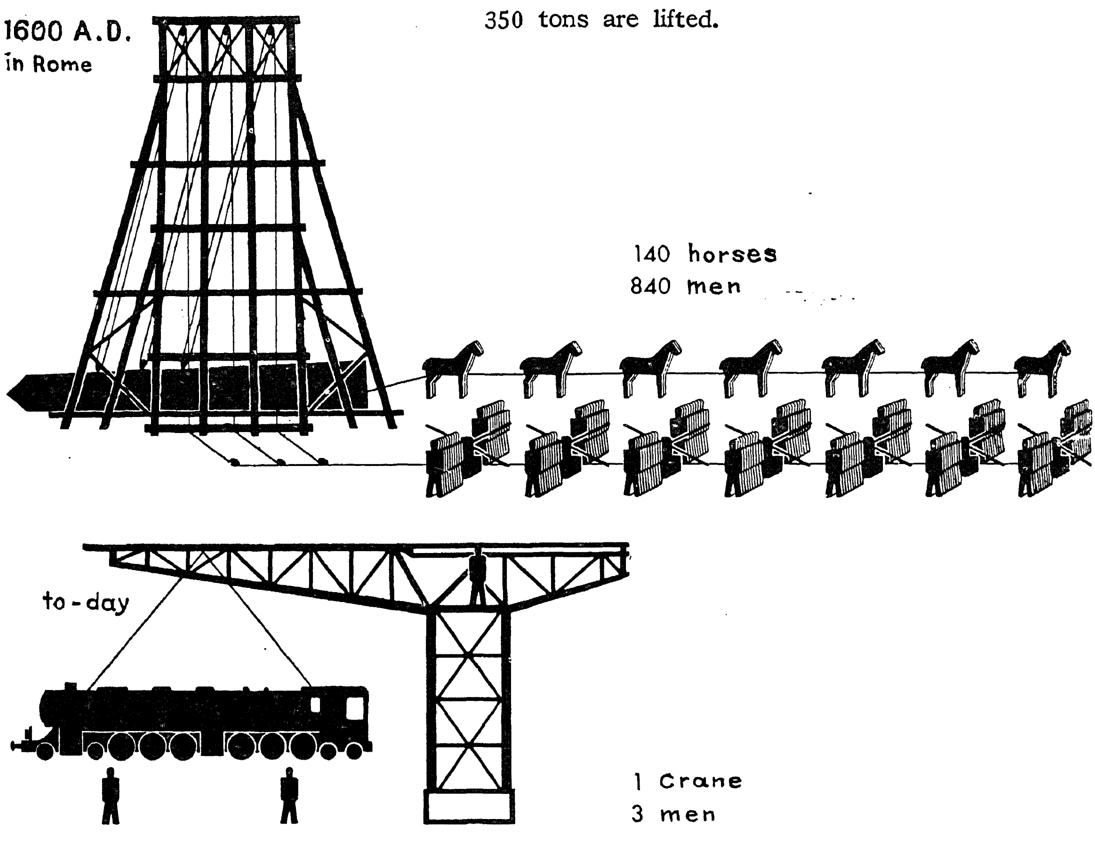

Fig. 3.

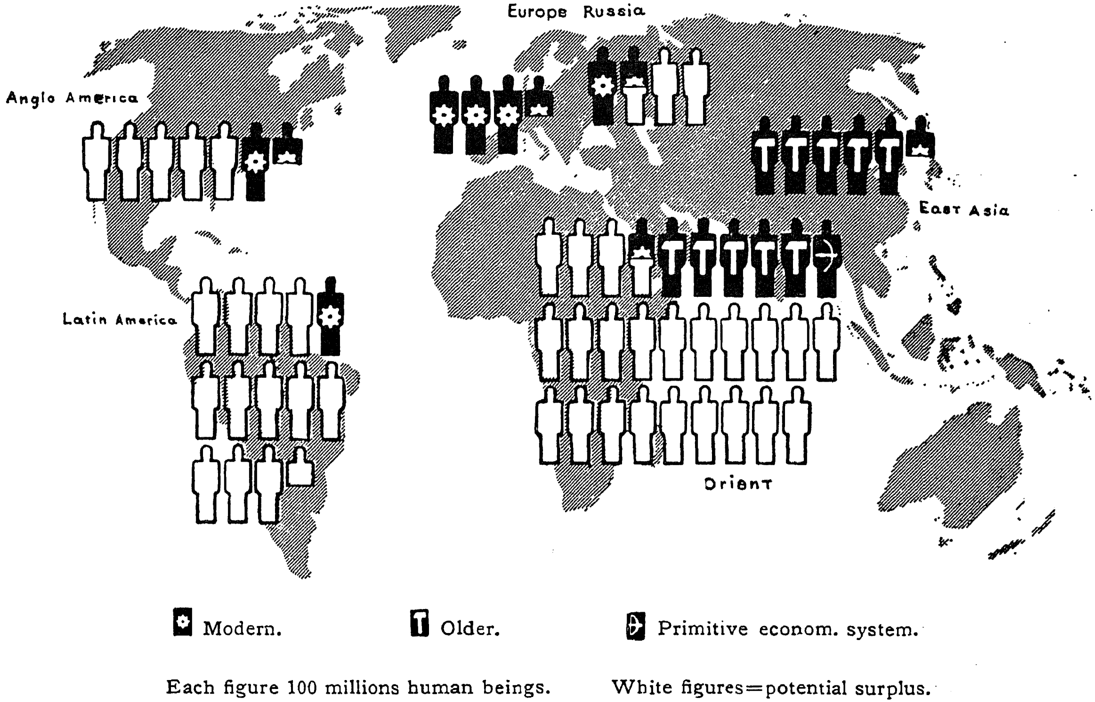

Fig. 4. Agricultural Productivity of the Continents.

to these few remarks, but any one who studies the new method more intensively will find it attractive and fascinating. It recommends itself to any teacher, lecturer or social worker; it is of extreme usefulness in social work and for adult education. This method appears to be of particular value to India, where the needs of education are so great, where the work of "uplifting the village" has become imminent and where the ideas and conceptions of western civilisation clash with those of an old tradition, rendering educational problems particularly difficult. The *Vienna Method* is eminently adaptable to Indian conditions; the more so, because the hieroglyphic language of the pictures can be understood by any one in complete disregard of the diversity of the spoken language.*

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* Further detailed information may be obtained from the "International Foundation for the Promotion of Visual Education." The Hague (Holland), Oberechtstraat 267.

Industrial Outlook.

Power Alcohol.

By Dr. N. G. Chatterji,
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ALCOHOL, in the form of a mixture with petrol, is being used in Europe as a "carburant" in motor cars for more than twenty years, but on account of certain technical difficulties vigorous steps could not be taken to push it on until the time of the appearance of absolute alcohol in large quantities in the market. The success achieved in the manufacture of water-free alcohol on a commercial scale made it economically possible to replace rectified spirit by this quality of alcohol in preparing alcohol-petrol mixtures, with the result that most of the technical difficulties with regard to the use of such mixtures became things of the past. Power alcohol may now be taken as almost synonymous with absolute alcohol of not less than 99·4% strength.

It may here be mentioned in passing that so long as rectified spirit was being used in the alcohol-petrol mixtures, it was *absolutely necessary* to incorporate into the mixture a certain proportion of benzol, in order that the latter may serve as a kind of "binder" and prevent the spirit-petrol mixture from separating into two layers, specially at low temperatures. But the miscibility of absolute alcohol and petrol is very high, so that the addition of benzol is no longer a necessity but may be regarded as a luxury, for alcohol-petrol mixtures containing benzol are sold at a higher price and are classed as 'super-carburants'.

Technical Methods of Manufacturing Power Alcohol.

Practically the whole of the world's manufacture of absolute alcohol is being carried out by one or other of the two processes, namely, (1) The *Azeotropic Process*, which is represented by (*a*) the French Process—the so-called D.D.S. (Distilleries des Deux Sêvres) or Melle Process, suing a mixture of benzine-benzol as the entraining liquid, the patents for the process held by Usines de melle, Melle, France. (*b*) The so-called "Drawinol" process of the Reichs-monopolver-waltung of Germany, using trichlorethylene as the entraining liquid. This process, however, is merely an adaptation of the D.D.S. process to suit certain local requirements and conditions. (2) *The Salt-dehydration Process*, or the Hiag Process, the patents for which are held by the Hiag-Verein of Frankfurt am Main, Germany.

By far the largest number of factories make power alcohol by the Melle Process, not only because it is the oldest, but also because in its latest improved form it has considerable advantages over the Hiag Process.

Principles of Working of the Processes.

Azeotropic Processes depend upon the fact that when rectified spirit which contains about 4·5 per cent. of water and 95·5 per cent. of alcohol is mixed with a certain quantity of some other liquid, say benzol or trichlorethylene, and the whole is distilled, the first portions to distil off is a mixture of alcohol, the added liquid, and water in a fixed proportion, because such a ternary mixture is most volatile. Now the proportion of water in such mixtures is considerably higher than its proportion in rectified spirit, so that if enough of the 'entraining liquid' is added and the distillation carried on long enough, the rectified spirit is gradually exhausted of its water content in meeting the demands of the ternary mixture, which would be the first to get into the vapour condition as it is the most volatile. In case there remains a surplus of the 'entraining liquid', a binary mixture in definite proportions of this liquid and alcohol is next formed, for such a mixture in its turn is more volatile than either alcohol or the liquid alone. Finally, when the quantity of the entraining liquid also is exhausted in this way, there remains only pure anhydrous alcohol. Some details of the Melle Process have been described by Caupin.[1]

Some of the salient points connected with this process are given below :—

(1) This process gives 100 per cent. alcohol in works practice.

(2) The process can be worked either with rectified spirit, or with raw spirit, or directly from fermented wash.

(3) The purity of the alcohol is high even when the impurities in the raw alcohol are considerable and of different kinds.

(4) The existing distilleries equipped with rectifying columns can easily be adapted

[1] *Current Science*, February, 1935.

to work on this process by small additions and alterations.

(5) It requires the use of an "entraining liquid" which works in the process in a cycle. The working losses of this liquid may not be higher than 0·075 per cent. of the quantity of absolute alcohol produced.

(6) Starting with fermented wash and adopting the improved process known as the Melle 4th technique, the "head and tails" fractions may not be more than 5 per cent. of the total quantity of alcohol distilled. In other words, out of every 100 parts of alcohol present in the fermented wash, as high as 95 parts may easily be obtained in the form of absolute alcohol, the rest as "mauvais goût", fit for being used in making "methylated spirit".

(7) The cost of production of absolute alcohol may be taken to be practically the same as that of rectified spirit made in the ordinary rectifying plants.

(8) Plants made for this process work almost automatically and can easily be managed by one intelligent workman. They have no moving parts to get out of order or to require constant attention.

The *Hiag Process* depends upon the very strong hygroscopic properties of anhydrous alkali acetates, which when treated with rectified spirit abstracts water from it making it practically water-free. The salt, after being made anhydrous by heating to a temperature of about 300° C., is suspended in a certain quantity of absolute alcohol, and in this form flows down a tower packed with Raschig rings, meeting in counter-current vapours of rectified spirit rising from the bottom. Thus dehydrated alcohol vapours come out from the top while hydrated salt in alcohol flows away from the bottom. The salt is recovered, dehydrated and used again in the process.

The more important features of this process may be summarised as follows:—

(1) It is not possible to get 100 % alcohol; in works practice, 99·8 % alcohol is obtained, which is of course high enough for making motor fuel compositions.

(2) The process may not work very satisfactorily for a length of time, unless the spirit treated has been carefully rectified. For this reason in the preliminary process of rectification, a fairly large proportion—about 12 per cent.— may have to be cut out as "head and tail" fractions. In other words, out of every 100 parts of alcohol present in the fermented wash, not more than 90 parts at the most, can be obtained in the form of absolute alcohol.

(3) Superheated steam is necessary for dehydrating the salt, and making it active.

(4) The dehydrating salt is cheap; moreover, the loss in use is almost negligible.

The patentees of both the processes are not directly interested in the manufacture and sale of plants, which may be ordered from any of the firms, who have obtained the permission for doing the same from the former.

SOME PROPERTIES OF ALCOHOL-PETROL MOTOR FUEL.

The properties of alcohol-petrol mixtures as motor fuel have been very carefully investigated by a large number of people, particularly by Prof. Hubendick in Sweden, Prof. Wawrziniok in Dresden, Lascot in Prague, Dumanois in Paris, and the Polish Alcohol State Monopoly. The cumulative result of these investigations has been to establish firmly the superiority of alcohol-petrol mixtures (within definite proportions) over straight petrol, when used in motor cars. It seems, however, that there is still a certain amount of prejudice against these mixtures, partly due to ignorance and partly to propaganda carried on by interested opponents. Of the more common criticisms, some are mentioned below:—

(*a*) Alcohol has lower calorific value and hence there must be increased consumption of this fuel per mile. This objection is based on a fallacy, for it assumes that in ordinary motoring practice there is complete conversion of the theoretical heat content of petrol into mechanical power, which is far from truth. On the contrary, the addition of a certain amount of alcohol to petrol, brings about more complete combustion of the air and fuel vapour mixture in the cylinder, and increases the nett efficiency, as it is possible to work such mixtures under higher compression ratio.

(*b*) Alcohol attacks some parts of the motor—much fuss seems to have been made on this point, because the cylinder of an autobus of the Paris Transport Co., using mixed fuel was found to be abnormally corroded. This was later traced to be due to thiophene contained in the benzol, a small quantity of which had been mixed in the fuel. Exhaustive experiments have shown that absolute alcohol has no corrosive action on ordinary metals used in the construction of motor car engines. Prolonged periods of use in Paris omnibuses of fuel

mixtures made with even rectified spirit, have not revealed any undue corrosion.

(c) Difficulty in the starting of motors has sometimes been cited, but this is not at all likely to be experienced in India, even during the severest winter, for with absolute alcohol added in the right proportion, there is neither the risk of any separation of the alcohol and petrol, nor a lowering of the vapour pressure of the liquid fuel.

On the other hand, the advantages offered by the addition of alcohol to petrol are many. The most important of these is the antidetonant property which enables an alcohol fuel to be used under higher compression than ordinary petrol, resulting in the production of more power. Another useful property conferred by alcohol is that it prevents pre-ignition and knocking of the engine. But probably what is likely to be most appreciated by the motorist is the anti-calamine property of alcohol. When carburation of the engine is not perfectly regulated, as is likely to be in town driving, there is deposited on the walls of the explosion chamber of the engine a hard black incrustation known as calamine. The harmful effects of this carbon deposition are too well known. Due to the more complete combustion of the mixed fuel, the engine remains clean for much longer periods, for there is practically no carbon deposition in the cylinder.

It is perhaps worthwhile to mention one property of alcohol fuel, namely its solvent action for the resinous material which gradually gets deposited from petrol on the inside of the car reservoir. The result is that when an alcohol-petrol mixture is filled for the first time in the tank, the incrustations may get dissolved, and getting deposited in the filter cause choking and annoyance. Within a short time, however, the tank becomes clean and the cause of the likely trouble is over.

COST OF MANUFACTURE IN INDIA.

The question of the probable cost of manufacture of power alcohol in India is of great importance, and every effort has been made to show that the cost would be much higher than that of petrol brought from Burma. But careful estimates show that with molasses at -/4/- per maund, the cost of manufacture may vary from -/6/3 to -/4/9 per gallon, according to the nature of the distillery. It is therefore necessary to emphasise on the fact that the semi-official estimates made in 1932 are now acknowledged to be too high, for at that time, first-hand knowledge of the industry was not available. One may thus take it that the cost of power alcohol in the sugar growing parts of India would be the same as that of Burma petrol, c.i.f. Calcutta, which is stated to be -/5/- per gallon.

POWER ALCOHOL AND MOLASSES.

Great interest is now being taken in India in the problem of the utilisation of molasses, the production of which has very rapidly increased with the growth of the sugar industry. But curiously enough little attention seems to have been given to the fact that the quantity of this material which is actually likely to be surplus would be just sufficient to produce the quantity of power alcohol that may be required to supply the country's need. Thus the estimated maximum production of molasses is 450,000 tons per annum, while the consumption is about 175,000 tons, so that the surplus in molasses is some 275,000 tons.

The present annual consumption of petrol in India may be taken as 82 million gallons. On a 20 : 80 alcohol-petrol mixture basis, the quantity of alcohol required would be 16·4 million gallons. To produce this quantity of alcohol, the amount of molasses required would be about 273,000 tons, which is almost exactly equal to the amount of molasses lying surplus in the country.

IMPORTANCE OF POWER ALCOHOL INDUSTRY.

There can be no question about the immense national importance of establishing the power alcohol industry in every country, especially after the recent announcement of the Oil Sanctions Enquiry Committee that in order to make oil sanctions effective, there must also be the power alcohol sanction. The gravity of the question has always been recognised, and as early as 1920, Government appointed the Industrial Alcohol Commission, who reported very strongly in favour of developing the power alcohol industry. After mature consideration, the Government of India accepted these recommendations (*Resolution No.* 6 *of October* 1, 1927) and ordered that power alcohol as such should not be handicapped by the imposition of any excise duty. But in spite of this encouragement and practical sympathy of the Government of India, the establishment of the industry was not economically possible on account of the high price and non-availability of the necessary raw materials. But curiously enough when there is an abundant and incessant

supply of molasses in the country, interest in power alcohol manufacture is being casually revived not for its own sake but as a means for utilising this by-product which has become almost a nuisance for sugar factory management.

COMMON OBJECTIONS AGAINST POWER ALCOHOL DEVELOPMENT IN INDIA.

It may be of interest to examine briefly some of the more important arguments that have been advanced even from authoritative quarters against the development of the power alcohol industry in India.

(1) *The possibility of exporting molasses* outside India through a foreign agency is now being banked upon largely for getting rid of surplus molasses. Here tacit assumption is being made that power alcohol industry should be regarded merely as a by-products industry twice removed and is of no intrinsic importance at all! And yet huge sums of money have been given as State grant to establish the "Synthetic Petrol" industry in The United Kingdom in order to have an independent supply of liquid fuel in the country. In addition to this, the Chancellor of the Exchequer has persistently refused to impose any duty on power alcohol.

Apart from the fact that it would never be possible for any agency to export molasses produced within but a limited area from the port towns, there is at least one strong reason why every effort should be made to establish the power alcohol industry in the country for its own sake, even if a fair price were obtained for molasses exported out of the country. With the separation of Burma from India, it is certainly a matter of national importance to have an indigenous motor fuel to combat against the possible evils of a virtual monopoly in petrol held by a private company outside India. As matters stand there is even now no protection against any arbitrary rise in price of petrol, for it is too well known that laws of economics play very minor part in fixing the price of this commodity in any country. It may also just happen, as has been pointed out by some, that for the improvement of the industry or the finances of the country, a cess on the export of Burma petrol may be imposed, the burden of which would fall on the consumers in India.

(2) There is no doubt that the *Burma petrol industry would be adversely affected*, but due considerations should also be given to the fact that during the last two years, there has been a natural increase in consumption of petrol in India by at least 8 million gallons. In fairness, herefore, the power alcohol industry may legitimately claim for a share in the increased market, especially in those areas where power alcohol can be marketed at the same price as petrol.

(3) The question of the *loss of revenue to Government* may, after all, be not very serious, especially if power alcohol be introduced in the sugarcane areas, far away from port towns, and where the cost of manufacture and distribution would be low enough to bear an excise duty almost equal to the present petrol duty. At the same time, it may be pointed out that with the separation of Burma, the whole of the incometax derived from the petrol industry would be lost. A part of this may, however, be recovered by developing the power alcohol industry in India.

POWER ALCOHOL AND LEGISLATIVE MEASURES.

The necessity for some kind of legislative protection is absolutely necessary during the initial stages of the development of the industry. This has been the experience of practically every country in Europe where power alcohol is being used. Probably the simplest measure that may be taken is to fix a minimum sale price for petrol within the province, based on the present average market price, so that unfair cut-in-price competition may not be possible. Such a measure would also indirectly give protection to the Burma petrol industry, which is alleged to be threatened by what is reported to be foreign dumped oil.

CONCLUDING REMARKS.

From what has been said above, one may say that the conditions in India are ideal in every way for the development of the power alcohol industry. We have an abundant supply of cheap molasses, a large internal market which is expanding rapidly, best climatic conditions for getting more favourable results from the use of alcohol-petrol mixtures, and political changes in the constitution of the land making it almost imperative to have an independent supply of motor fuel spread out all over the country. Last but not least power alcohol offers the best economic advantages to the country for the utilisation of molasses, for it would be seen that out of every -/6/- per gallon involved in the cost of manufacture of power alcohol, only -/1/- (cost of denaturants and patent licence fee) really goes out of the country, in contrast to at least -/3/- per gallon in the case of petrol brought from outside.

Research Notes.

Zeros of Legendre-Polynomials.

SZEGO (*Trans. Am. Math. Soc.*, **39**, 1-17) has derived very interesting results concerning the zeros of Legendre-polynomials, Bessel's functions and certain trigonometrical polynomials in an entirely elementary way. The method consists in applying in a modified form the classical theorem of Sturm concerning the zeros of functions defined by means of a linear second order equation. [For an analogous method, see *e.g.* Courant-Hilbert, *Methoden der Mathematischen Physik.*, Ed. II.] The modified form runs as follows: Let $y(x)$ and $Y(x)$ satisfy the equations $y'' + f(x)y = 0$, $Y'' + F(x)Y = 0$. Further let $y(x) > 0$ in $a < x < b$. $y(b) = 0$ and $\lim\limits_{x \to a+0} \{y'Y - yY'\}$ exists and $\geqslant 0$. Then either Y is identically zero or else it will be negative in some subintervals of $\{a, b\}$. As an immediate consequence of this is the following theorem, *viz.*, if $\phi(x)$ be continuous and decreasing then the sequence of zeros of $y(x)$, any solution of $y'' + \phi(x)y = 0$ is convex. (Szego makes the conditions on $\phi(x)$ less restrictive.) The method of application of these results consists in comparing the equations that are satisfied by $P_n(x)$ or $J_n(x)$ with equations, the nature of the roots of the solutions of which are known. For instance, the second order equation satisfied by $y = \sqrt{\sin\theta} \times P_n(\cos\theta)$ is $y'' + \{(n+\frac{1}{2})^2 + (2\sin\theta)^{-2}\} y = 0$; this is compared with the equation $y'' + (n+\frac{1}{2})^2\, y = 0$. By applying these two theorems Szego proves the results of Markoff-Bruns-Stieltjis in a slightly sharpened form. He has proved that if θ_ν is the νth zero of $P_n(\cos\theta)$ in the interval $(0, \pi/2)$ then

$$\frac{(\nu - \frac{1}{4})\pi}{n+\frac{1}{2}} < \theta_\nu < \frac{\nu}{n+1}\pi.$$

Analogous results are proved in the case of Bessel's functions of all orders and associated Legendre functions. By comparing the equations satisfied by $J_0(x)$ and $P_n(\cos\theta)$, he has also deduced interesting relations connecting the zeros of these two functions. In the second part of the paper he has obtained results concerning the uniformity of distribution of zeros of polynomials of the type

$$\sum_{(t)} \lambda_{m-t} \begin{matrix}\cos\\ \sin\end{matrix}\, \theta t \quad \text{and} \quad \sum_{(t)} \lambda_{m-t} \begin{matrix}\cos\\ \sin\end{matrix}\, (t+\tfrac{1}{2})\theta$$

where λ_ν is a monotonic decreasing sequence.

For the proofs the only result that is used is the known elementary result that $\sum\limits_{m=0}^{\nu} \sin\frac{(2m+1)\theta}{2}$ is $\geqslant 0$ for all ν. Sharper inequalities are derived for the case when the λ's form a convex sequence. He has also obtained simple proofs, with generalisations of some known theorems of Polya and of some results concerning the regularity of distribution of zeros of polynomials of the type

$$\sum_{0}^{[n/2]} a_k\, a_{n-k} \cos(n-2k)\theta \quad (a > 0).$$

He has obtained some more precise results in case the a_n's are capable of being defined as the moments {interval (0, 1)} of a positive function.

K. V. I.

Trigonometric Series and Power Series with (Multiply) Monotonic (*Mehrfach-monotone*) Sequence of Coefficients.

FEJER (*Trans. Am. Math. Soc.*, **39**, 18-59) has obtained a series of theorems concerning polynomials and power series of the type mentioned in the title in a very elementary way. He has deduced a great number of results concerning the rest series [*e.g.*, $\Sigma\, c_\nu \cos(\nu + r)\theta$] and in particular has obtained the result of Szego concerning the distribution of zeros of $P_n(\cos\theta)$. There are some results concerning the positivity of partial sums of various orders of trigonometric polynomials whose coefficients are multiply-monotonic. Incidentally he has given a very simple proof of Heine's sine-series derivation for $P_n(\cos\theta) = \Sigma\, c_\nu \sin(n+2\nu+1)\theta$, and has obtained the interesting result that the sequence c_ν is 3-ply monotonic. He has made this too evident by obtaining the formula

$$\frac{\pi}{4}\cdot c_\nu = \Sigma \frac{a_k\, a_{n-k}}{2k + 2\nu + 1}$$

where

$$a_k = \frac{1\cdot3\cdot5\cdots(2k-1)}{2\cdot4\cdot6\cdots2k}.$$

(It can also be obtained by expressing Heine's formula for c_ν in terms of partial fractions.) It is not possible to reproduce here all the important results contained in the paper. The following illustrate the types of important results obtained:—

1. If a_ν is a monotonic sequence then the cesaro-means of the first order of the sum of the series $\Sigma\, a\nu \sin(2\nu+1)\theta$ are all non-negative.

2. If $f(\theta) = \Sigma\, a_\nu \sin(\nu+1)\theta$, and $\lim\limits_{n\to\infty} a_n = 0$. Then $f(\theta)$ cannot be throughout negative in any interval $(0, \alpha)$.

3. If a_ν is a positive non-increasing sequence, and $\lim a_n = 0$, then if $\theta_1, \theta_2, \cdots \theta_n$ are the zeros in $(0, \pi)$ of $f(\theta) = \sum\limits_0^\infty a_\nu \sin(n + 2\nu + 1)\theta$ are such that

$$\frac{(k-1)\pi}{n} < \theta_k < \frac{k\pi}{n}.$$

If, moreover, a_ν is 2-ply monotonic (then the zeros are symmetrically distributed about $\pi/2$) then

$$\frac{(m-1)\pi}{n+1} < \theta_m < \frac{m\pi}{n+1};$$

if the sequence is 3-ply monotone

$$\frac{(m-\frac{1}{2})\pi}{n} < \theta_m < \frac{m\pi}{n+1}.$$

There are two results concerning the *schlicht* nature of power-series whose coefficients are monotonic. These are,

If $f(z) = \sum\limits_1^\infty c_\nu z^\nu$, and c_ν is 4-ply monotonic, then $f(z)$ is *schlicht* in the unit-circle; and if $f(z)$ is an odd-function then $f(z)$ is *schlicht* in the unit-circle even if the coefficient-sequence is only 3-ply monotonic.

These results are proved by investigating the *bild-curves* of $|z| = r < 1$, and showing that they have no multiple points.

K. V. I.

The Neutrino Theory of Light.

FOLLOWING a suggestion of De Broglie (*Comptes Rendus*, 1934, 199, 813) but altering his ideas in an essential way, P. Jordan has recently developed a neutrino theory of light. (*Zs. f. Phys.*, 1935, 93, 464; 1936, 98, 709 and 759.) The neutrino is conceived as an elementary particle with a spin $\frac{1}{2}\,\frac{h}{2\pi}$ and a rest-mass zero; its existence was originally suggested by Pauli in order to account for the continuous β-ray spectra of radioactive bodies. (The idea has been employed by Fermi to develop a theory of β-decay.) De Broglie assumed that a quantum $h\nu$ of light was made up of two neutrinos of energy $h\nu/2$ and he attempted to deduce Maxwell's equations for the quantum from the Dirac equation of the neutrino. Jordan, on the other hand, does not consider the quantum as a real entity at all, but thinks that only neutrinos produce the effects usually attributed to a quantum when a pair of them enter simultaneously into the reaction. Thus the absorption of a quantum $h\nu$ is described in the neutrino-theory as either a simultaneous absorption of any two neutrinos of energy $h\nu_1$ and $h\nu_2$ such that $\nu_1 + \nu_2 = \nu$ or the absorption of one neutrino $h\nu'$ and the emission of another of less energy $h\nu''$ such that $\nu' - \nu'' = \nu$ (Raman effect of the neutrinos as Jordan calls this latter process). From this point of view Jordan has been able to prove that while the neutrinos having spins of $\frac{1}{2}$ obey Fermi-Dirac Statistics, the apparent entity—the quantum—must follow Bose-Statistics. In the neutrino processes considered above, not only should the conditions $h\nu_1 + h\nu_2 = h\nu = h\nu' - h\nu''$ be satisfied but also the neutrinos $h\nu_1$ and $h\nu_2$ must have parallel spin-axes as also the neutrinos $h\nu'$ and $h\nu''$. Kronig has been able to show how to set up a Lorentz invariant connection between the field, E, H obeying Maxwell's equations and the spinor field $\psi_1, \psi_2, \psi_3, \psi_4$ of the neutrinos which obeys a Dirac wave-equation. Now Jordan has tried to develop the physical significance of his theory by assuming two kinds of neutrinos—positive and negative —and assumes that in every light process the difference between the numbers of positive and negative neutrinos remains constant and shows that the mathematical results of Kronig receive a simple interpretation in terms of this hypothesis. In this way a close analogy has been set up between electron-positron pairs and γ-rays on the one hand and a positive-negative neutrino pair and the quantum on the other hand. By considering a unidimensional cavity to which Thermodynamical considerations are applied Jordan then shows that when and only when there are equal numbers of positive and negative neutrinos do we get a pure radiation field.

T. S. S.

Direct Measurement of the Absolute Amount of Adsorption in Liquid Surfaces.

McBAIN has been associated with the development of several new experimental methods useful in adsorption studies. To mention a few, we have the quartz spring technique for following the rate of adsorption, the precision

beam-type quartz microbalance, the ultra-filtration method for the determination of bound water and the microtome method for measuring adsorption at the plane liquid-vapour interface. In a recent communication (*J. Am. Chem. Soc.*, 1936, **58**, 378), has been described two new methods for measurement of adsorption which involve the use of the Hilger Raleigh Interferometer. The two methods, referred to as the 'compressed surface' and the 'submerged surface' method, are both claimed to be applicable to any type of solution whatsoever. The method has given good results with an aqueous solution of β-phenylpropionic acid.

K. S. G. D.

Determination of Melting Point of Organic Substances.

A COMMUNICATION on the above subject by F. Francis and F. J. E. Collins in the *Journal of the Chemical Society* (1936, p. 137) should be of great interest to all chemists as it discusses in detail the classical determination of melting points by the capillary tube method. The authors have designed an apparatus by means of which different observers can obtain results which do not differ by more than 0·03°. The essential modification, apart from such improvements as electrical heating and mechanical stirring, is in the method of observation for which a telescope incorporating a periscope device is used so that in the same eyepiece both capillary and thermometer scale can be viewed together. There is also described another apparatus by means of which the setting points can be determined correct to ± 0·01° with but 2 gr. of material. It is found that invariably the melting point determined by the capillary tube method is higher than the setting point, but the latter is nearer to the temperature at which the molten material allowed to cool very slowly commences to solidify in the capillary tube. This temperature thus affords a better value for the melting point of a substance than the criterion used at present.

M. A. G. RAU.

Purification of Gallium by Fractional Crystallisation of the Metal.

JAMES I. HOFFMAN AND BOURDON F. SCRIBNER [*Journal of Research of the National Bureau of Standards*, U. S. Department of Commerce, September 1935, **15**, (3), 205] give the results obtained in a systematic investigation of the suitability of a process of fractional crystallisation for obtaining gallium in a state of high purity starting from the metal containing small amounts of various impurities. It was found that most of the impurities (some 20 other metals) tended to concentrate in the crystalline portion, and only a few impurities like silver and lead remained behind in the molten residue. Copper and thallium were found to be distributed about equally between the crystals and the residue. It was also found that the removal of iron, platinum, iridium and lead was impracticable except when the elements were present in very small amounts.

The detection and estimation of the impurities were carried out by examination of the sensitive lines of the elements, employing the stigmatic concave-grating spectrograph described previously by Meggers and his co-workers.

K. R. K.

A Study of Sagger Clays and Sagger Bodies.

RAYMOND A. HEINDL [*Journal of Research of the National Bureau of Standards*, U. S. Department of Commerce, September 1935, **15**, (3), 255] presents in detail the results obtained in a laboratory investigation of various specimens of simple and blended clays, this being undertaken with a view to determine their suitability for the production of saggers of desired quality.

Each of the various grogs employed in the mixtures had been heated to about 1200°C. before being crushed and graded. The test specimens consisted of bars of 1 sq. in cross-section and of different lengths up to 12″, and also of oval saggers 4″ × 4″ × 6″ × ½″. The tests carried out included (*a*) water of plasticity, (*b*) the volume and linear shrinkage during drying, (*c*) porosity, (*d*) modulus of rupture, (*e*) pyrometric cone equivalent (softening point), (*f*) linear thermal expansion from room temperature to 1000° C., (*g*) relative resistance to thermal shock, (*h*) Young's modulus of elasticity and (*i*) plastic deformation. The addition of talc or magnesia in small quantities to sagger mixes was found to be beneficial but larger additions were injurious owing to their detrimental effect on the refractoriness of clay.

The large amount of valuable data obtained in this investigation are presented graphically as well as in tabular statements.

K. R. K.

(*Research Notes continued on p. 683*)

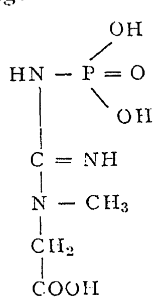
SUPPLEMENT TO "CURRENT SCIENCE".

Neue Versuche über den Mechanismus der enzymatischen Kohlehydratspaltung (Milchsäurebildung und alkoholische Gärung).*

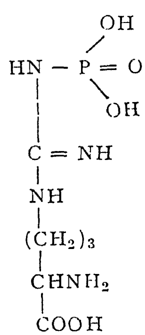
Von Professor Otto Meyerhof, L.L.D.

(Aus dem Institut für Physiologie am Kaiser Wilhelm-Institut für Medizinische Forschung, Heidelberg.)

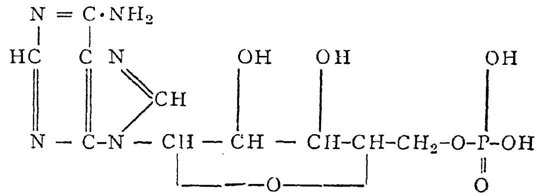
DER Umfang des Gebietes, über das ich zu berichten habe, ist in den letzten Jahren so gewachsen, dass ich mich notwendig auf einen kleinen Teil, der die gemeinsam mit K. Lohmann und W. Kiessling ausgeführten Arbeiten der jüngsten Zeit umfasst, beschränken muss. Neben dem aeroben und dem anaeroben Umsatz des Kohlehydrats im Muskel haben in den letzten Jahren vor allem zwei andere, am Tätigkeitsstoffwechsel beteiligte Substanzen das Interesse der Forschung auf sich gezogen; einmal das von Eggleton und Fiske entdeckte Phosphagen, die Kreatinphosphorsäure, die bei der Tätigkeit in Kreatin und Phosphorsäure gespalten und dann wieder resynthetisiert wird. Im Wirbellosenmuskel tritt an ihre Stelle die Argininphosphorsäure, die in unserm Institut aufgefunden wurde.[1] Und zweitens die Adenylpyrophosphorsäure oder Adenosintriphosphorsäure, die in ähnlicher Weise in ihre Bestandteile Adenylsäure und 2 Mol anorganische Phosphorsäure zerfällt und daraus wieder aufgebaut werden kann. Diese Substanz und ihre Umsetzungen wurde von K. Lohmann in unserm Institut entdeckt, während die Adenylsäure schon vorher von Embden im Muskel aufgefunden wurde, sowie ihr Zerfall in Ammoniak und Inosinsäure. Zwischen der Adenosintriphosphorsäure und der Adenosinmonophosphorsäure wurde kürzlich von Lohmann auch noch die Adenosindiphosphorsäure als Zwischenprodukt festgestellt. Die folgenden Formeln sind jetzt endgültig gesichert.[2]



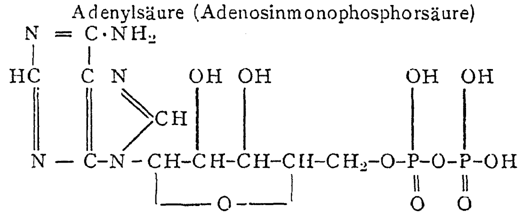
Kreatinphosphorsäure



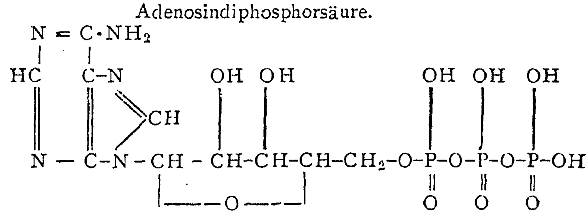
Argininphosphorsäure



Adenylsäure (Adenosinmonophosphorsäure)



Adenosindiphosphorsäure.



Adenylpyrophosphorsäure (Adenosintriphosphorsäure)

In meinem Bericht werde ich mich im wesentlichen beschränken auf die Intermediärreaktionen des Kohlehydrats selbst, die zur Bildung von Milchsäure führen. Wir können sie am besten studieren in einem zellfreien Extrakt, der die Enzyme enthält, aber kohlehydratfrei ist und zu dem man Glykogen oder auch Zucker und geeignete Aktivatoren zusetzt. Dieser Extrakt, besonders wenn man daraus noch durch Dialyse alle kleineren Moleküle entfernt, hat seit dem Jahre 1926, wo er zuerst von uns hergestellt wurde, für zahlreiche Fragen als geeignetes Material gedient.[3]

* Nach einem Vortrag, gehalten in der Biologischen Gesellschaft in Wien am 2. December 1935.

[1] O. Meyerhof u. K. Lohmann, *Biochem. Z.*, 1928, 196, 22.

[2] K. Lohmann, *Biochem. Z.*, 1935, 282, 120.

[3] O. Meyerhof, *Biochem. Z.*, 1926, 178, 395.

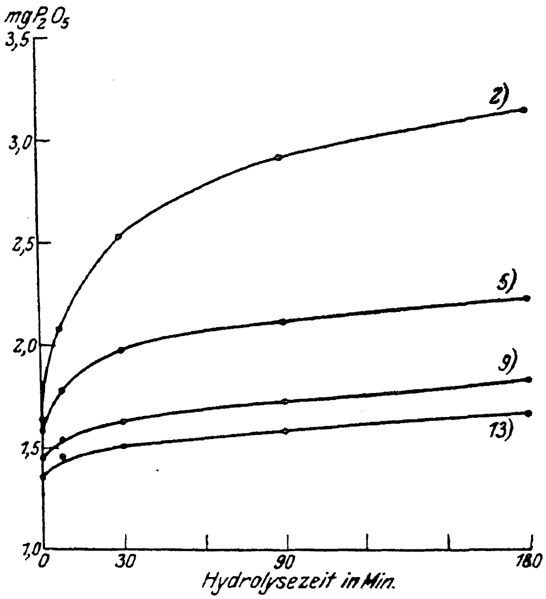


Abb. 1.

Hydrolysekurven. Umwandlung der Harden-Youngschen Hexosediphosphorsäure in Froschmuskelextrakt in Gegenwart von 0,01 n Fluorid bei 20° nach 10,45,120 Minuten.

Kurve 2 Anfangswert.
„ 5 mit Fluorid nach 10 Minuten.
„ 9 „ „ „ 45 „
„ 13 „ „ „ 120 „

Die Umwandlung des Harden-Young Esters ist nach 45 Minuten beendet. Der senkrechte Abstand der einzelnen korrigierten Nullwerte entspricht der Spontanveresterung des Extrakts.

Salzsäure bei 100°, ist ein äusserst wichtiges Hilfsmittel zur Untersuchung des Umsatzes der phosphorylierten Verbindungen geworden, vor allem auch zur Auffindung neuer, noch unbekannter Phosphorsäureester. Sie hat auch Embden den Weg zur Auffindung der Phosphoglycerinsäure gewiesen. Da die Phosphoglycerinsäure 1 Stufe höher oxydiert ist als die Hexosediphosphorsäure, so musste gleichzeitig ein reduziertes Produkt entstehen, wofür Embden zutreffend die α-Glycerinphosphorsäure annahm, die wir um diese Zeit, wie ihm unbekannt war, gerade isoliert hatten. Auch die anderen Reaktionen liessen sich zur Hauptsache experimentell verifizieren, vor allem die letzte Reaktion des Embden-Schemas zwischen Brenztraubensäure und α-Glycerinphosphorsäure. Im Endeffekt müssen bei überschüssiger Brenztraubensäure pro Mol α-Glycerinphosphorsäure 2 Mol Milchsäure auftreten nach der Gleichung,

$$\begin{array}{lll} CH_3 & CH_2OH & \quad CH_3 \\ C=O\ + & CHOH & =2CHOH + H_3PO_4 \\ COOH & CH_2\cdot O\cdot PO_3H_2 & \quad COOH \end{array}$$

aber da nur die links drehende Komponente reagiert, gilt das nur für die natürliche α-Glycerinphosphorsäure. Bei der racemischen dagegen, wo nur eine Hälfte reagiert, muss pro Mol Glycerinphosphorsäure nur 1 Mol Milchsäure entstehen. Das ist nun in der Tat bei Totalumsatz ganz genau der Fall, wie die Kurven der Abbildung 2 zeigen.

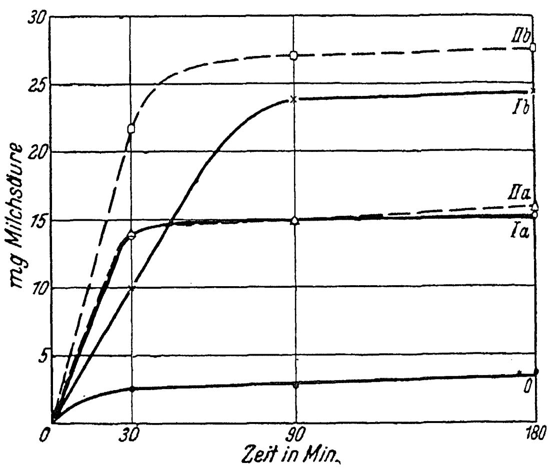


Abb. 2.

Verlauf der Milchsäurebildung in 10 ccm Extrakt mit natürlicher und synthetischer α-Glycerinphosphorsäure.

Kurve O: Milchsäurebildung ohne Zusatz.

Ausgezogene Linien Ia und Ib: Synthetische Glycerinphosphorsäure mit 11, 7 und 24 mg Glycerin.

Gestrichelte Linien IIa und IIb: Natürliche Glycerinphosphorsäure mit 5, 9 und 11, 9 mg Glycerin,

(Im letzteren Falle entspricht die Differenz der Milchsäurebildung gegenüber dem Leerwert genau dem Doppelten des zugesetzten Glycerins. Bei der synthetischen Säure stimmen Milchsäurebildung und Glyceringehalt überein.)

Dass aber die hier vorliegende Reaktion nur eine Bilanzgleichung darstellt und der Umsatz wirklich, wie Embden annimmt, über eine Triosephosphorsäure führt, zeigt sich in Gegenwart von Fluorid. Fluorid unterbricht die Reaktionskette hinter der Phosphoglycerinsäure. Es hindert aber nicht die Dismutation zwischen Brenztraubensäure und α-Glycerinphosphorsäure. Infolgedessen wird in Fluorid die α-Glycerinphosphorsäure zu Phosphoglycerinsäure oxydiert unter Aufnahme von 2 Sauerstoffatomen und dafür werden 2 Mol Brenztraubensäure zu Milchsäure.

$$\begin{array}{lclcl}
\ \ CH_3 & & CH_2OH & & \ \ \ CH_3 & & COOH \\
\ \ | & & | & & \ \ \ | & & | \\
2C=O & + & CHOH & = & 2CHOH & + & CHOH \\
\ \ | & & | & & \ \ \ | & & | \\
\ \ COOH & & CH_2\cdot O\cdot PO_3H_2 & & \ \ \ COOH & & CH_2\cdot O\cdot PO_3H_2
\end{array}$$

Dies erklärt sich so, dass bei der Dismutation, von α-Glycerinphosphorsäure mit Brenztraubensäure Milchsäure und Triosephosphorsäure entstehen und die letztere dann wieder in Phosphoglycerinsäure und Glycerinphosphorsäure dismutiert, die Phosphoglycerinsäure aber dann durch Fluorid gleichsam in eine Falle gerät.

Die Vorlegung des Embden-Schemas gerade im Augenblick unserer eigenen Arbeiten über dieses Thema hat sehr anregend auf die weitere Arbeit gewirkt, wobei ich zwei Etappen unterscheiden möchte. Die erste Etappe bestand in der Auffindung und Isolierung teils einzelner im Schema aus theoretischen Gründen schon postuiierten Zwischenstufen, wie der Triosephosphorsäure, teils anderer dabei nicht vorausgesehener weiterer Intermediärprodukte. Hierbei ergaben sich auch höchst eigenartige Gleichgewichtsreaktionen, durch die die phosphorylierten Zwischenprodukte mit einander in Verbindung stehen. Die zweite Etappe, die erst neuen Datums ist und jetzt zum Abschluss gebracht wurde, bestand darin, das Schema selbst einer bedeutenden Abänderung zu unterziehen, um den raschen Abbau zu Milchsäure damit zutreffend wiederzugeben.

Ich beginne mit der ersten Etappe. Das hauptsächliche Mittel zur Isolierung der Zwischenstufen und Untersuchung ihres Umsatzes ist die Dialyse des Enzymextrakts. Dadurch wird das Adenylsäuresystem und das Magnesium entfernt und infolgedessen auch alle Reaktionen aufgehoben, die mit Aufnahme oder Abgabe von Phosphat verknüpft sind. Eine Reihe anderer Reaktionen findet aber noch statt und dies sind merkwürdigerweise vor allem umkehrbare Reaktionen. Schon früher hatte K. Lohmann auf diese Weise eine umkehrbare Reaktion gefunden, die noch vor dem eigentlichen Abbau liegt, nämlich die Umwandlung der am Anfang vorgeführten Hexosemonophosphorsäuren, der Aldosephosphorsäure und Ketosephosphorsäure.[16] Es hatte sich ergeben, dass der natürliche Robison-Embden-Ester, der in Wirklichkeit nicht reine Glukosemonophosphorsäure ist, sondern aus zwei Teilen Glukose- und einem Teil Fruktosephosphorsäure besteht, ein Gleichgewichtsester ist und dass sich, ausgehend von den reinen Verbindungen enzymatisch also ein Gleichgewicht herstellt. Diese Beobachtung erklärte, warum neben der Hexosediphosphorsäure, die eine reine Fruktosediphosphorsäure ist, zur Hauptsache Glukosemonophosphorsäure in den Enzymextrakten vorhanden ist. Sobald nämlich eine Phosphorsäuregruppe aus dem Diester enzymatisch abgespalten wird, wandelt sich der Monoester in das Gleichgewichtsgemisch um.

Die erste Abbaustufe, die man aus Hexosediphosphorsäure im Enzymextrakt erreicht, ist die Dioxyacetonphosphorsäure. Diese Etappe war von Embden vor allem aus theoretischen Erwägungen eingesetzt. Auch war damals schon die Glycerinaldehydphosphorsäure bekannt geworden, die H. O. L. Fischer synthetisiert hat und die enzymatisch Milchsäure bildet und mit Hefeextrakt zu Alkohol und Kohlensäure vergären kann.[17] Auch andere Autoren hatten Hinweise auf die Triosephosphorsäure gefunden. Die direkte Isolierung und Darstellung der Triosephosphorsäure gelang uns, als wir erkannten, dass die Hexosediphosphorsäure sich in dialysiertem Extrakt umwandelt in eine Verbindung, die durch schwaches Alkali bei Zimmertemperatur in Phosphorsäure und Milchsäure verseift wird. Dieselbe Reaktion gab die Fischersche Glycerinaldehydphosphorsäure. Tatsächlich war unsere Substanz, die von K. Lohmann isoliert werden konnte, das Isomere, nämlich die Dioxyacetonphosphorsäure.[18] Das wurde zuerst dadurch bewiesen, dass sie mit Jod und Brom nicht reagierte. Schliesslich wurde sie von Dr. Kiessling synthetisiert und damit die Identität sichergestellt. Da die Substanz kein asymmetrisches C-Atom besitzt, so kann auch der synthetische Triosester zu 100 % vergären. Im folgenden ist der chemische und der enzymatische Umsatz der beiden Triosephosphorsäuren schematisch dargestellt. Merkwürdigerweise ist nun die Spaltung von Hexosediphosphorsäure in Dioxyacetonphosphat reversibel und bei dieser Reaktion ist genau

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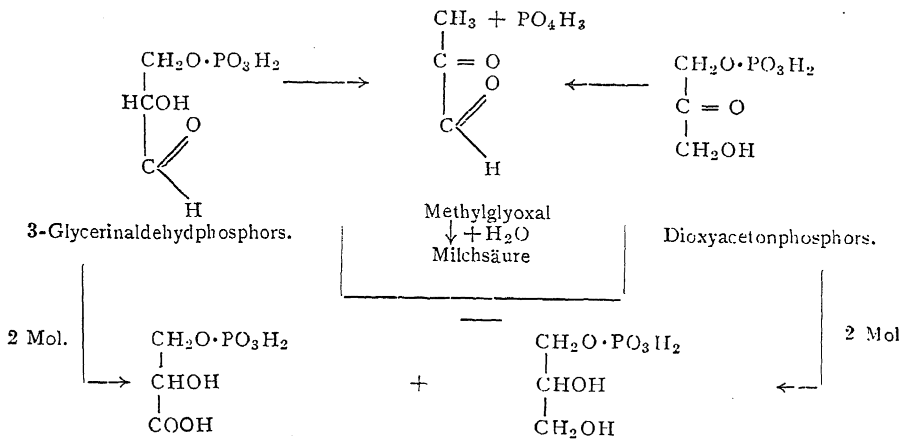
16 K. Lohmann, *Biochem. Z.*, 1933, **262**, 137.

17 H. O. L. Fischer u. E Baer, *Ber. Chem. Ges.*, 1932, **65**, 337 u. 1040.

18 O. Meyerhof u. K. Lohmann, *Biochem. Z.*, 1934, **271**, 89; 1934, **273**, 73; 1934, **273**, 413; 1935, **275**, 430.



die Forderung des Massenwirkungsgesetzes erfüllt (Abbildung 3).

$$K = \frac{c^2\,(\text{Diox.})}{c\ (\text{Hex.})}$$

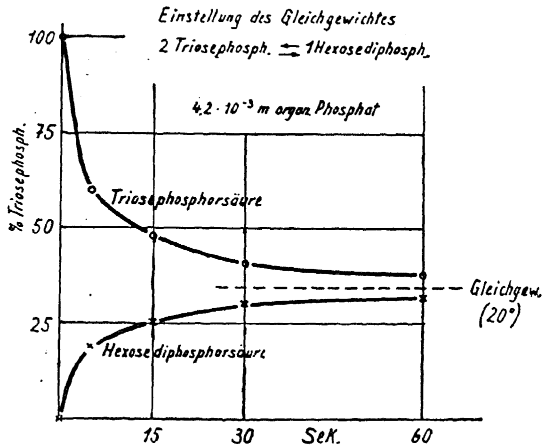


Abb. 3.

Ordinate : % Triosephosphorsäure.
Abszisse : Zeit in Sekunden.

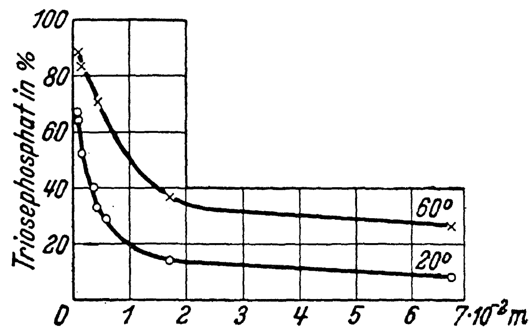


Abb. 4.

Gleichgewicht (2-Triosephosphorsäure ⇄ 1 Hexosediphosphorsäure) bei wechselnder Gesamtkonzentration des gebundenen Phosphats.

Ordinate : Triosephosphorsäure.

Abszisse : 10^{-2} mol gebundenes Phosphat.

×—×—× Gleichgewichtseinstellung bei 60°.

o—o—o Gleichgewichtseinstellung bei 20°.

Ferner ist dieses Gleichgewicht stark temperaturabhängig und gehorcht genau der für ein temperaturabhängiges Gleichgewicht gültigen Isochorengleichung von van t'Hoff. Auf Abbildung 5 sehen Sie die Abhängigkeit des log K von der reziproken Temperatur. Nach der van t'Hoff'schen Gleichung $\left(d \log K = -\frac{Q}{RT^2}\right)$ berechnet sich daraus für die Spaltung eine negative Wärmetönung von —12 000 g cal. Experimentell haben wir diese Wärme gemessen und zu —14 000 g cal pro Mol gefunden. Es ist dies die erste messbare negative Wärmetönung, die bei einer freiwilligen enzymatischen Spaltung aufgefunden ist. Ich kann mich aber nicht länger bei dieser interessanten Reaktion aufhalten und will nur noch sagen, dass sich auch die synthetische Glycerinaldehydphosphorsäure enzymatisch in die Dioxyacetonphosphorsäure umwandelt.[19] Nicht ganz sicher, aber wahrscheinlich liegt hier auch ein Gleichgewicht vor, das sehr zugunsten der Dioxyacetonphosphorsäure verschoben ist und in diesem Falle ist dann die Gleichung zu formulieren :

Hexosediphosphat ⇌ 2 Dioxyacetonphosphat
⇌ 2 Glycerinaldehydphosphat.

Eine zweite Reihe umkehrbarer Reaktionen findet sich bei der schon vorher erörterten, von Embden aufgefundenen Spaltung der Phosphoglycerinsäure zu Brenztraubensäure. Im dialysierten Muskelextrakt erhält man

[19] O. Meyerof u. W, Kiessling, *Biochem. Z.*, 1935, **279**, 40.

zwei weitere phosphorylierte Zwischenprodukte, die in der folgenden Gleichung aufgeführt sind,

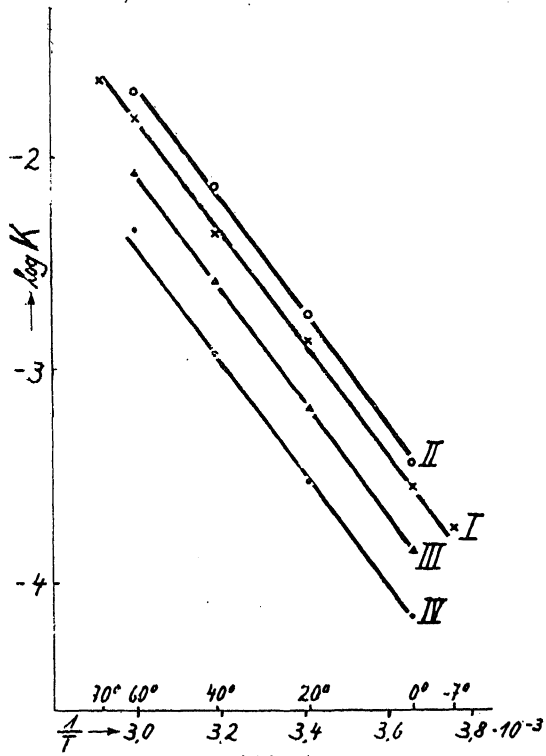


Abb. 5.

Abhängigkeit der Gleichgewichtskonstanten K von der Temperatur.

Ordinate: $\log_{10}$ K.

Abszisse: 1/T abs. (Die Messtemperaturen sind in °C. angegeben).

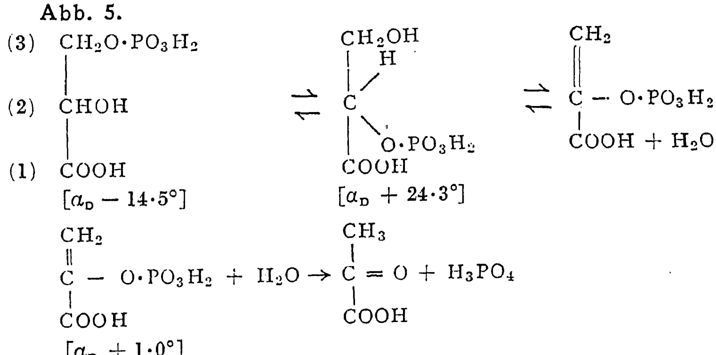
I ×—×—× Mittelwerte für eine Fermentverdünnung ¼ und Esterphosphat $4 \cdot 10^{-3}$ mol.

II o—o—o Dasselbe für Fermentverdünnungen 1/16 bis 1/32.

III ▲—▲—▲ Dasselbe für Fermentverdünnungen 1/16 und 0·006 mol, $MgCl_2$.

IV ● — ● — ● Fermentverdünnungen 1/16 und maximal wirksame $MgCl_2$—Konzentration (0·12 bis 0·06 m).

Die log K liegen auf parallelen Geraden in Uebereinstimmung mit der van't Hoff'schen Isochorengleichung (für konstante Wärmetönung der Reaktion).



nämlich die 2-Phosphoglycerinsäure und die (enol) Brenztraubensäurephosphorsäure (Phosphobrenztraubensäure). Bis dahin bestand keine Sicherheit über die Konstitution der Phosphoglycerinsäure. Man nahm stillschweigend an, dass es sich hier um 3-Phosphoglycerinsäure handelt und das hat sich dann auch insoweit als zutreffend erwiesen, als der Hauptteil der gewöhnlich isolierten Substanz 3-Phosphoglycerinsäure ist. Diese 2- und 3-Phosphoglycerinsäure unterscheiden sich aber durch ihre Löslichkeit und vor allem durch ihre optische Drehung. Sie konnten von Dr. Kiessling beide isoliert und auch synthetisiert werden.[20] Die Phosphobrenztraubensäure wurde von K. Lohmann als kristallisiertes Silber-Bariumsalz isoliert und dann auch von Kiessling synthetisiert.[21] Diese Verbindungen stehen mit einander in Zusammenhang durch weitere Gleichgewichtsreaktionen, die eine geringe

[20] W. Kiessling, *Ber. Chem. Ges.* 1935, **68**, 243; O. Meyerhof u. W. Kiessling, *Biochem. Z.*, 1935, **276**, 239.

[21] K. Lohmann u. O. Meyerhof, *Biochem. Z.*, 1934, **273**, 60; W. Kiessling, *Ber. Chem. Ges.*, 1935, **68**, 597.

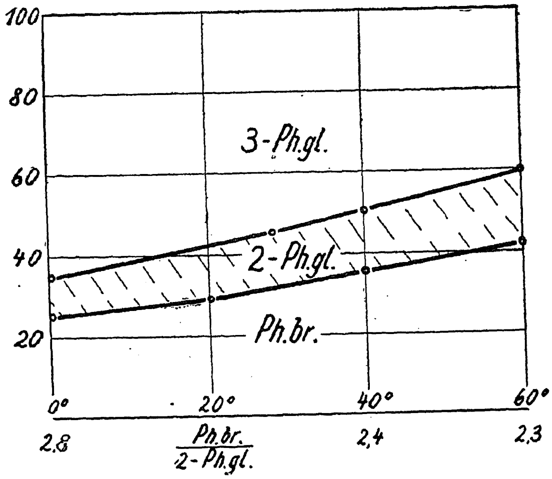


Abb. 6.

Verteilung zwischen 3-Phosphoglycerinsäure, 2-Phosphoglycerinsäure und Phosphobrenztraubensäure im Gleitchgewicht bei verschiedener Temperatur. Die gestrichelte Fläche stellt den Anteil von 2-Phosphoglycerinsäure dar, die darüber befindliche Fläche denjenigen von 3-Phosphoglycerinsäure, die unten befindliche den Anteil von Phosphobrenztraubensäure. Das Verhältnis $\frac{\text{Phosphobrenztraubensäure}}{\text{2-Phosphoglycerinsäure}}$ ist danach annähernd temperaturunabhängig.

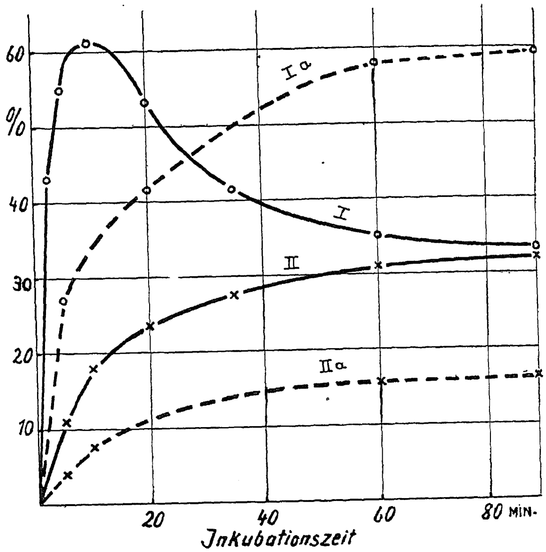


Abb. 7.

Verlauf der Phosphobrenztraubensäurebildung in der Restlösung des Tierkohlenadsorbats.

O—O—O I Bildung aus 2-Phosphoglycerinsäure.
O--O--O Ia mit 2.10^{-2} n NaF.
×—×—× II Bildung aus 3-Phosphoglycerinsäure.
×--×--× IIa mit 2×10^{-2} n NaF.

Die Fluoridhemmungen sind in diesem Fall noch unvollständiger und ergeben im wesentlichen nur Verlangsamung der Geschwindigkeit der Einstellung. Infolgedessen geht das Maximum im Falle von Ia in der Versuchszeit nicht zurück wie das Maximum von I. Hier ist noch so viel Phosphoglyceromutase vorhanden, dass aus 2-Phosphoglycerinsäure und 3-Phosphoglycerinsäure in 90 Min. das vollständige Gleichgewicht der 3 Komponenten entsteht.

Abhängigkeit von der Temperatur zeigen. Abb. 6 ist ein Diagramm, wie sich die 3 Verbindungen verteilen. Jedes dieser Gleichgewichte, dasjenige zwischen 3-Phosphoglycerinsäure und 2-Phosphoglycerinsäure, sowie das zwischen 2-Phosphoglycerinsäure und Phosphobrenztraubensäure kann man aber auch für sich beobachten. Man bekommt dann z.B. den auf Fig. 7 dargestellten Zeitverlauf. Das letzte Stück der Reaktionskette, die Aufspaltung der Phosphobrenztraubensäure zu Brenztraubensäure + Phosphorsäure ist nun eine typische Umesterungsreaktion. Die Phosphobrenztraubensäure wird in dialysiertem Enzymextrakt nicht gespalten, sondern erst nach Zusatz von Adenylsäure und dies beruht eben darauf, dass die Adenylsäure sich dabei zu Adenylpyrophosphat umestert, ohne Abspaltung von anorganischem Phosphat. Diese Reaktion wurde im Institut von J. K. Parnas als Teil der von ihm entdeckten Umesterung der Phosphoglycerinsäure zu Kreatinphosphorsäure aufgefunden,[22] übrigens unabhängig davon auch in unserm Institut von H. Lehmann.[23] Nun gibt es zwischen diesen beiden Reihen umkehrbarer Reaktionen, die ich genannt habe, noch einen Uebergang, den wir in Gegenwart von Fluorid leicht realisieren können. Die Reaktion nämlich: 2 Triosephosphorsäure → Phosphoglycerinsäure + α-Glycerinphosphorsäure.

Diese Reaktion hat sich bisher als nicht umkehrbar erwiesen. Sie geht aber auch ohne Aenderung des Phosphatbestandes einher und daher auch in der Tat noch bei stärkster Verringerung des Adenylsäuresystems, aber vielleicht doch nicht bei völligem Fehlen aller Cofermentbestandteile, jedenfalls nicht mehr in so lange ausdialysierten Extrakten wie die bisher beschriebenen Reaktionen. Möglicherweise ist an dieser Reaktion nicht das Adenylsäuresystem, sondern die davon verschiedene Eulersche Cozymase beteiligt. Ich muss dies aber offen lassen, weil diese Frage noch nicht vollständig geklärt ist.

Nun komme ich zu der zweiten oben genannten Etappe unserer Arbeiten. Sich mit

22 J. K. Parnas, *Klin. Ws.*, 1935, 1317.
23 O. Meyerhof u. H. Lehmann, *Naturwiss.*, 1935, 23, 337.

dem bisherigen, d. h. mit dem Embden-Schema, soweit es vorlag und den Modifikationen, die durch die neu aufgefundenen Zwischenreaktionen nötig wurden, noch nicht zu beruhigen, dazu gab die Erkenntnis Veranlassung, dass einzelne Reaktionen, vor allem die zwischen Brenztraubensäure und α-Glycerinphosphorsäure meist viel langsamer und mit schlechterer Ausbeute abliefen als die Milchsäurebildung aus Glykogen oder Hexosen. Wie Aubel und Simon in Paris zeigten,[24] kann man ein Acetonpulver aus Muskulatur herstellen, das noch aus Glykogen Milchsäure bildet, aber nicht mehr in dem System Brenztraubensäure + α-Glycerinphosphorsäure. Das war natürlich ein ernster Einwand. Von den echten Zwischenreaktionen muss man verlangen, dass sie unter gleichen Umständen mindestens so gut und mit mindestens derselben Geschwindigkeit vor sich gehen, wie die Gesamtreaktion. Wenn dies nicht der Fall ist und sogar ein einzelnes Teilglied unter Umständen ausfällt, so kann man sicher sein, dass etwas noch nicht in Ordnung ist. Die Beobachtung von Aubel und Simon ist zutreffend. Man kann besonders leicht durch Fällung nicht der Muskulatur selbst, wie die Autoren es taten, sondern durch Fällen des Muskelextrakts mit Aceton, ein Pulver herstellen, dessen wässriger Auszug Glykogen und, in Verbindung mit einem Hefeaktivator, den ich früher angab, auch Glukose in Milchsäure umwandelt, aber nicht mehr mit α-Glycerinphosphorsäure die Brenztraubensäure. Die französischen Forscher wollten in ihrer Beobachtung den Beweis erkennen, dass hier die Spaltung über Methylglyoxal ginge. Das Methylglyoxal, das man unter solchen Umständen finden kann, rührt jedoch von dem spontanen Zerfall der Dioxyacetonphosphorsäure her. Dieser Zerfall geschieht auch in Abwesenheit des Ferments; er ist also nicht enzymatisch, in den wenigen Minuten aber, die in ungeschädigten Fermentextrakten für die maximale Milchsäurebildung ausreichend sind und in denen das zugesetzte Kohlehydrat verbraucht wird, entsteht überhaupt keine messbare Menge Methylglyoxal, auch dann nicht, wenn Glutathion abwesend ist. Des Rätsels Lösung für diesen negativen Befund der französischen Autoren ist vielmehr eine ganz andere.[25] Tatsächlich ist nämlich die α-Glycerinphosphorsäure nicht *die* phosphorylierte Zwischenstufe, die hauptsächlich die Brenztraubensäure zu Milchsäure reduziert, sondern vielmehr die Triosephosphorsäure und schematisch lautet die letzte Reaktion

Triosephosphorsäure + Brenztraubensäure	=	Phosphoglycerinsäure + Milchsäure.

Diese Reaktion kann direkt zwischen der Dioxyacetonphosphorsäure, die im Gleichgewicht aus Hexosediphosphorsäure entsteht, und der Brenztraubensäure ablaufen. Eine entsprechende Reaktion, nämlich Milchsäurebildung aus Brenztraubensäure in Gegenwart von Hexosediphosphat und Fluorid, ist von Dische im hämolysierten Blut beobachtet worden.[26] Rascher geht aber diese in der Gleichung wiedergegebene Reaktion, wenn man von Glykogen oder von Glukose in Gegenwart des schon erwähnten Hefeaktivators ausgeht. Diese werden dann zunächst verestert und es bildet sich ein Produkt, das ich als primäres Veresterungsprodukt bezeichne und das man als eine Hexosediphosphorsäure in status nascens oder auch als ein Radikal auffassen kann. Dieses zerfällt viel rascher als die Harden-Youngsche Diphosphorsäure, die eine Art Stabilisierungsprodukt vorstellt. Nun, sowohl mit Hexosediphosphat wie auch mit Glykogen oder Glukose reduziert sich in Fluorid Brenztraubensäure zu Milchsäure, wobei das frisch veresterte Kohlehydrat auf dem Wege über Triosephosphorsäure zu Phosphoglycerinsäure oxydiert wird. Das Fluorid fängt gleichsam die Phosphoglycerinsäure ab und der Vorgang bleibt stehen, entweder wenn die ganze zugesetzte Brenztraubensäure zu Milchsäure geworden ist oder im Falle von Glykogen oder Glukose das ganze anorganische Phosphat zu Phosphoglycerinsäure verestert ist. Einen Eindruck von den vergleichsweisen Geschwindigkeiten der Reaktion haben Sie auf den Kurven (Fig. 8). Hier ist die normale Milchsäurebildung aus Glykogen beziehungsweise Glukose ohne Fluorid verglichen mit der Milchsäurebildung aus Brenztraubensäure mit Fluorid und zwar auch in Gegenwart von Glykogen beziehungsweise Glukose. Der Pfeil oben links gibt die Menge am Anfang zugesetzter Brenztraubensäure beziehungsweise anorganischen Phosphats an. Wie genau der Umsatz stöchiometrisch verläuft, zeigt das folgende Bild (Fig. 9) und zwar ist hier die Reduktion der Brenztraubensäure zu

[24] E. Aubel u. E. Simon. *C. R. Soc. Biol.*, 1934, **114**, 905: **115**, 373, 1178.

[25] O. Meyerhof, u. W. Kiessling, *Biochem. Z.*, 1935, **283**, 83.

[26] Z. Dische, *Biochem. Z.*, 1935, **230**, 248.

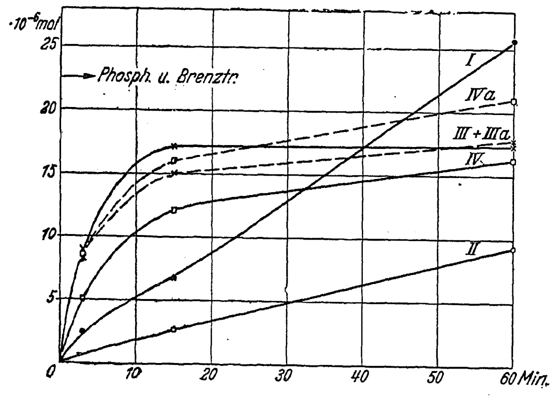


Abb. 8.

Vergleich der spontanen Milchsäurebildung aus Kohlenhydrat mit der Milchsäurebildung aus Brenztraubensäure in Gegenwart von Fluorid und Kohlenhydrat.

Umsätze pro 1 ccm frischem Kaninchenmuskelextrakt. Ausgezogene Kurven: Milchsäurebildung. Gestrichelte Kurven: Verbrauch des anorganischen Phosphats.

I •—• ohne Fluorid. Milchsäurebildung aus 3, 6 mg Glukose und Hexokinase.

II O—O Milchsäurebildung aus 3, 6 mg Glykogen, ohne Hexokinase (ohne Glykogen ist die Milchsäurebildung Null und nicht eingezeichnet).

III ×—× und IIIa ×---× Milchsäurebildung und Phosphatveresterung mit $3 \cdot 10^{-2}$ NaF, Brenztraubensäure und Glukose (Anfangsgehalt von Brenztraubensäure und Phosphat $22 \cdot 5 \times 10^{-6}$ mol.).

IV □—□, IVa □---□ ebenso. Brenztraubensäure und Glykogen. Man sieht, dass mit Glykogen zusätzliche P–Veresterung stattfindet.

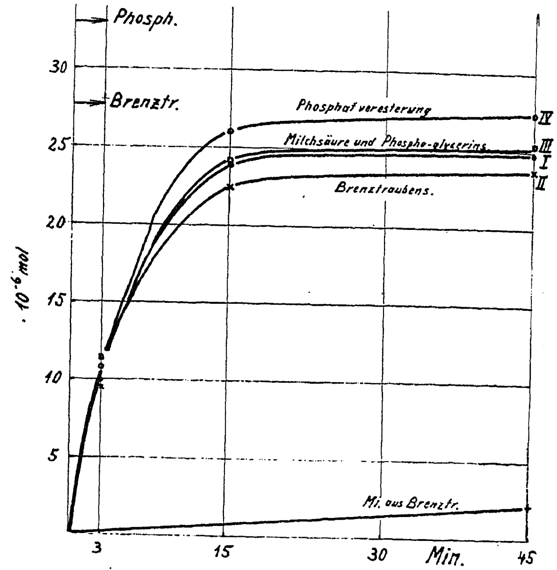


Abb. 9.

Kohlehydratumsatz in fluoridversetztem Extrakt aus Acetonpluver.

40 mg Pulver, Zusatz von Glukose und Brenztraubensäure (die Pfeile links geben den Anfangsgehalt von Benztraubensäure und anorganischem Phosphat an.) Umsatz in 10^{-6} mol.

I •—• Milchsäurebildung.

II ×—× Brenztraubensäureabnahme.

III □—□ Bildung von schwer hydrolysierbarem Ester.

IV O—O Abnahme des anorganischen Phosphats.

+—+ Milchsäurebildung mit Brenztraubensäure ohne Glukose.

Milchsäure in Gegenwart von Glukose vorgenommen, wobei sich die Glukose also mit Phosphat verestert und zu Phosphoglycerinsäure wird. Aufgezeichnet ist Milchsäurebildung, Brenztraubensäureschwund, Verbrauch von anorganischem Phosphat und Bildung von Phosphoglycerinsäure. Alles ist genau äquivalent, entsprechend der Gleichung:

$$\begin{matrix}\text{Glukose}+2\text{ Phosphat} \\ +2\text{ Brenztraubensäure}\end{matrix} = \begin{matrix}2\text{ Phosphoglycerinsäure} \\ +2\text{ Milchsäure}\end{matrix}$$

Auf Abbildung 10 ist nun auch in einem Muskelextrakt, der zur Milchsäurebildung aus Brenztraubensäure und α-Gylcerinphosphorsäure befähigt ist, die Geschwindigkeit dieser Milchsäurebildung verglichen mit derjenigen, die sich bei gleichzeitiger Oxydation des Veresterungsprodukts zu Phosphoglycerinsäure ergibt. Die erstere ist ausserordentlich viel kleiner. Stellt man denselben Versuch an mit einem Extrakt aus Acetonpulver, so ist überhaupt die Geschwindigkeit dieser Reaktion mit α-Glycerinphosphorsäure nahezu Null, dagegen die der anderen Reaktion ganz unverändert. Tatsächlich sind die übrigen Kurven, mit einem solchen Extrakt aus Acetonpulver angestellt. In diesem Fall ist die Reaktionsgeschwindigkeit bis nahe zum Verbrauch der Brenztraubensäure oder des vorhandenen Phosphats immer grösser als die spontane Milchsäurebildung und das gilt nach unsern Versuchen bei allen beliebigen Fermentextrakten und unter allen Versuchsbedingungen. Daraus müssen wir folgern, dass dieses auch die Reaktion ist, die letzten Endes für die rasche Milchsäurebildung verantwortlich ist.

Ehe ich nun das Schema für die Milchsäurebildung entwerfe, wie es sich aus allen Reaktionen ergibt, möchte ich kurz auf die analogen Zwischenglieder der alkoholischen Gärung eingehen, wobei ich mich allerdings auf einige wesentliche Punkte beschränken will.

Zwei Eigentümlichkeiten der alkoholischen Gärung, die sich ebenso, wenn auch nicht ganz so ausgesprochen, bei der enzymatischen Milchsäurebildung wiederfinden, seien zunächst erwähnt:

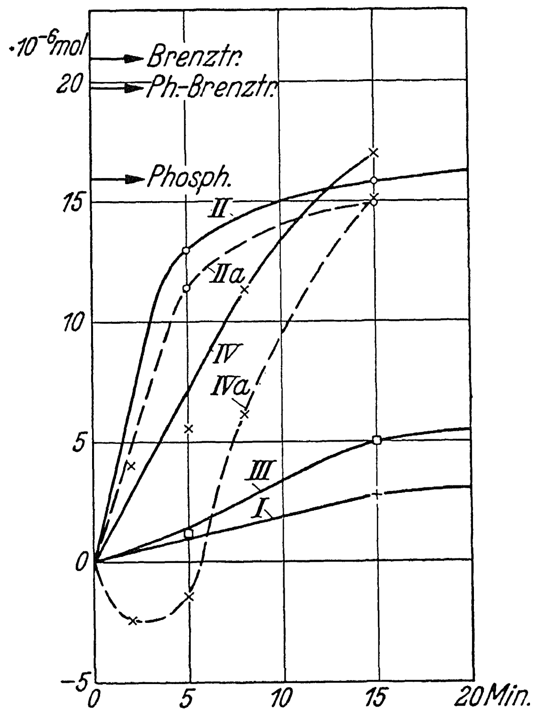


Abb. 10.

Milchsäurebildung und Phosphatveresterung beim Umsatz von Brenztraubensäure und Phosphobrenztraubensäure in Gegenwart von NaF. Pro ccm frischen Kaninchenmuskelextrakts. Ausgezogene Linien: Milchsäurebildung. Gestrichelte Linien: P–Veresterung. Die Pfeile links geben den Anfangsgehalt von Brenztraubensäure, Phosphobrenztraubensäure und anorganischem Phosphat an.

I +—+ Milchsäurebildung aus Brenztraubensäure allein.

II O—O und IIa O— — —O Milchsäurebildung und P–Veresterung mit Brenztraubensäure und Glukose (Der Umsatz fällt schon nach 5 Minuten ab wegen fast vollständiger Veresterung des präformierten Phosphats).

III □—□ aus Brenzträubensäure und α-Glycerinphosphorsäure.

IV ×—× und IVa ×— — — —× Milchsäurebildung und Phosphatveresterung aus Phosphobrenztraubensäure und Glukose (hier wird vorübergehend anorganisches Phosphat abgespalten).

erstens die sogenannte Induktions- und Angärungsperiode und dann die Harden-Young'schen Gleichungen. Die zellfreie Gärung setzt nach Zuckerzusatz niemals unmittelbar ein, es vergeht eine gewisse Induktionsperiode, bis die sogenannte Angärung beginnt und auch diese Angärung zeigt noch keine konstante Geschwindigkeit, sondern steigt langsam bis zum Maximum. Die maximale Geschwindigkeit hält dann so lange an, bis alles anorganische Phosphat verestert ist. Diese Phosphatveresterung findet aber ihren Ausdruck in der 1. Harden-Young'schen Gärungsgleichung. Während der raschen Periode der Gärung verestert sich, gleichzeitig mit der Vergärung eines Zuckermoleküls ein zweites zu Hexosediphosphat evtl. ein Teil zu Hexosemonophosphat,

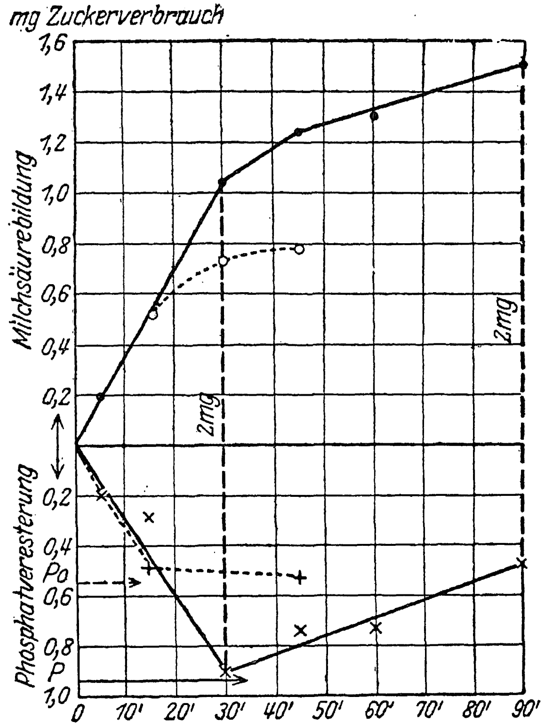


Abb. 11.

Umsatz von 2 mg Glukose durch Muskelextrakt mit Hexokinase.

•—• Milchsäurebildung } mit vermehrter Phos-
×—× Phosphatveresterung } phatmenge.

(Gehalt: 0,736 mg P_2O_5 äquivalent 0,942 mg Zucker. Die vertikalen gestrichelten Linien entsprechen dem Umsatz der im ganzen vorhandennen 2 mg Glukose.)

O- - -O Milchsäurebildung } ohne Phosphat-
+- - - -+ Phosphatveresterung } zusatz.

(Präformierter Gehalt: P_2O_5 0,356 mg, entsprechend 0,546 mg Zucker.)

P mit ausgezogenem Strich→Phosphatgehalt des 1. Versuchs.

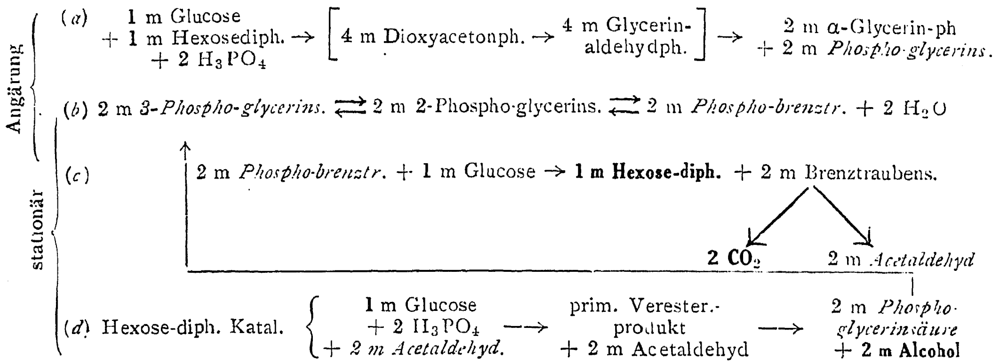
Po- - - -→gestrichelt, Phosphatgehalt des 2. Versuchs.

wobei das anorganische Phosphat verschwindet. Dieses Hexosediphosphat wird erst dann im Anschluss daran, nach Verbrauch alles anorganischen Phosphats, langsam selbst vergoren. Induktions- und Angärungsperiode hängen nun mit der Bildung von 2 Intermediärprodukten zusammen, durch deren vorherige Zugabe man sie abkürzen, beziehungsweise ganz beseitigen kann, nämlich einerseits Hexosediphosphat, andererseits Acetaldehyd. Gibt man beide

gleichzeitig von vornherein hinzu, so erhält man fast sofort die maximale Gärgeschwindigkeit. In weniger ausgesprochener Weise ist dies auch bei der Milchsäurebildung im Muskelextrakt der Fall. In diesem Falle kann man (nach einer Beobachtung von Lipmann)[27] die Induktionsperiode durch Brenztraubensäure beseitigen. Ferner erweist sich auch bei der Milchsäurebildung aus Glukose, die Harden-Young'sche Gärungsgleichung als gültig, nämlich in der ersten raschen Periode werden neben der Bildung von 2 Mol Milchsäure 2 Mol Phosphat zu Hexosephosphorsäure verestert[28]. (Abbildung 11).

Die genannten Eigentümlichkeiten nebst anderen werden nun durch das untenstehende Schema der alkoholischen Gärung

Ergänztes neues Gärungsschema (1935).



verständlich. Jede der angeführten Reaktionen lässt sich für sich nachweisen und verläuft dann unter gleichen Umständen mit derselben oder höheren Geschwindigkeit wie die ganze Gärung. Zunächst sieht man die Trennung der Angärungsperiode vom stationären Zustand, wobei die Angärungsperiode bis zur Bildung von Acetaldehyd führt. Hier ist zur Auslösung, d.h. zur Aufhebung der Induktionsperiode etwas Hexosediphosphat als vorgebildet eingesetzt. Man kann das in dem Schema vermeiden und, wie von Parnas vorgeschlagen ist, noch eine Gleichung an die Spitze stellen, die zur Bildung von Hexosediphosphat führt, nämlich den Umsatz von Glukose mit Adenylpyrophosphat. Wie Dr. Lohmann schon früher gezeigt hat und wie neue Versuche noch exakter ergeben, kann Adenylpyrophosphat das Hexosediphosphat bei der Angärung quantitativ ersetzen, eben dadurch, dass es sich mit Glukose umestert. Wenn nun Hexosediphosphat und Glukose zugegen sind, so reagieren sie zunächst nach der Gleichung *a*, unter weiterer Veresterung der Glukose über die Triosephosphorsäure zu Phosphoglycerinsäure und α-Glycerinphosphorsäure. Bei der Gärung tritt die α-Glycerinphosphorsäure nicht in Reaktion, sondern wird durch die Phosphatase zu Glycerin und Phosphorsäure aufgespalten. Die Phosphoglycerinsäure aber lagert sich nach den geschilderten Reaktionen zu Phosphobrenztraubensäure um. Aus dieser entsteht Brenztraubensäure und aus dieser Acetaldehyd und Kohlensäure und mit der Bildung des Acetaldehyds ist die Angärungsperiode zuende und es beginnt der stationäre Zustand.

Hier, bei dem Zerfall der Phosphobrenztraubensäure, findet noch eine eigenartige Umesterungsreaktion statt, die ich bisher noch nicht erwähnt habe und die tatsächlich für die Geschwindigkeit der Zuckergärung entscheidend ist. Die Phosphobrenztraubensäure wird nämlich in Gegenwart von Zucker ausserordentlich viel rascher aufgespalten als ohne diesen und zwar dadurch, dass das Phosphat auf den Zucker umgeestert wird.[29] Bei dieser Umesterung entsteht neben der freien Brenztraubensäure Hexosediphosphat. Diese rasche Umesterung geht nun ihrerseits über das Adenylsäuresystem vor sich, indem sich zunächst die Phosphobrenztraubensäure mit Adenylsäure zu Adenylpyrophosphat und Brenztraubensäure und dann das Adenylpyrophosphat mit Hexose zu Hexosediphosphat und Adenylsäure umsetzt. Das Adenylsäuresystem wirkt also überall wie ein Katalysator, indem es einen dauernden Kreislauf vollführt. Diese hier aufgeführte Reaktion *c* lässt sich

[27] F. Lipmann, *Biochem. Z.*, 1935, 276, 234.
[28] O. Meyerhof, *Biochem. Z.*, 1927, 183, 176.
[29] O. Meyerhof u. W. Kiessling, *Biochem. Z.*, 1935, **281**, 249.

für sich studieren, wenn man Phosphobrenztraubensäure in Gegenwart von Zucker vergären lässt unter Zusatz von Jodessigsäure. Die Jodessigsäure verhindert die Oxydoreduktion der Triosephosphorsäure, infolgedessen schreitet die Reaktion der Glukose nur bis zum Hexosediphosphat beziehungsweise bis zum Triosephosphat fort, während auf der andern Seite die freiwerdende Brenztraubensäure bis zu Acetaldehyd und Kohlensäure gespalten wird. Wenn wir aber den Hefeextrakt, der mit denselben Stoffen versetzt ist, nicht mit Jodessigsäure, sondern mit Fluorid vergiften, so schreitet die Reaktion weiter fort und nunmehr spielt sich auch noch die Gleichung *d* ab. Sobald Acetaldehyd entstanden ist, reagiert dieser mit einem weiteren Zuckermolekül, das sich neu verestert und von ihm zu Phosphoglycerinsäure oxydiert wird, wobei er selbst zu Alkohol reduziert wird. Hierbei kommt es auch zu intermediärer Bildung von Triosephosphorsäure, die aber nicht noch einmal besonders aufgeführt ist. Bei dieser Reaktion *d* entsteht also wieder Phosphoglycerinsäure, die dann nach b wieder in Reaktion tritt, was so lange geht, bis der ganze Zucker verbraucht ist. Zum Ablauf der Reaktion ist eine Spur Hexosediphosphat erforderlich und dies wird, wie man sieht, wenn es nicht schon vorgegeben ist, dauernd durch die Reaktion *c* nachgebildet. Man sieht ferner, dass hier als Endprodukt neben 2 Mol Kohlensäure und 2 Mol Alkohol 1 Mol Hexosediphosphat entsteht, wie es die Harden-Young'sche Gleichung vorschreibt.

Ein ganz entsprechendes Schema kann man nun auch für die Milchsäurebildung aufstellen, wobei ebenfalls das Postulat erfüllt ist, dass alle Reaktionen im stationären Zustand mindestens ebenso rasch ablaufen wie die Gesamtreaktion. Das Schema ist auch dadurch mit dem Gärungsschema eng verwandt, dass es genau dieselben Intermediärprodukte bis auf den Acetaldehyd enthält. Dabei stellt die Brenztraubensäure das biologische Aequivalent des Acetaldehyds dar und die Milchsäure das biologische Aequivalent des Alkohols. Im Falle der Milchsäurebildung setzt der stationäre Zustand ein, wenn Brenztraubensäure gebildet ist, die in entsprechender Weise mit dem Veresterungsprodukt der Hexosen reagiert und dieses zu Phosphoglycerinsäure oxydiert, wobei sie zu Milchsäure reduziert wird. Da jetzt die Angärungsperiode durch Brenztraubensäure aufgehoben wird, so sind die Initialreaktionen zuende, sobald Brenztraubensäure entstanden ist.

Schema des Hauptweges der Milchsäurebildung.

Initialreaktion

1. 2 mol. Hexose + 2 mol. Adenylpyrophosphat = 2 mol. *Hexosediphosphat* + 2 mol. Adenylsäure

2. 2 mol. *Hexosediphosphat* ⇌ 4 mol Dioxyacetonphosphat (⇌ 4 mol. Glycerinaldehydphosphat) ↗ 2 mol. α-Glycerinphosphat ↘ 2 mol. *Phosphoglycerinsäure*

Stationärer Zustand

3. 2 mol. *3-Phosphoglycerinsäure* ⇌ 2 mol. 2-Phosphoglycerinsäure ⇌ 2 mol. *Phosphobrenztraubensäure*

4. 1 mol. Hexose + 2 mol. *Phosphobrenztraubensäure* → 1 mol. **Hexosediphosphat** + 2 mol. *Brenztraubensäure*

5. 1 mol. Hexose + 2 mol. *Brenztraubensäure* + 2 mol. Phosphat → primäres Veresterungsprodukt + 2 mol. Brenztraubensäure → 2 mol. Triosephosphat + 2 mol. Brenztraubensäure → 2 mol. *Phosphoglycerinsäure* + 2 mol. **Milchsaure**

5a. 1 mol. Hexosediphosphat + 2 mol. Brenztraubensäure → 2 mol. Dioxyacetonphosphat + 2 mol. Brenztraubensäure → 2 mol. Phosphoglycerinsäure + 2 mol. Milchsäure

Die Reaktionen des Embden-Schema gehören danach in die Initialperiode. Ich habe hier noch die Bildung der Hexosediphosphorsäure durch die Umesterung von Hexose mit Adenylpyrophosphat als die Primärreaktion eingesetzt, weil man tatsächlich nachweisen kann, dass die Hexosediphosphorsäure im Muskelextrakt auf diesem Wege entsteht, wobei dann die Adenylsäure bei dem Zerfall der Phosphobrenztraubensäure wieder anorganisches Phosphat aufnimmt. Vom Hexosediphosphat an folgen nun dieselben Zwischenreaktionen wie bei der Gärung bis zur Brenztraubensäure, dann aber ändert es sich, weil der carboxylatische Zerfall in Kohlensäure und Acetaldehyd fehlt. Die Brenztraubensäure tritt vielmehr direkt, wie ich es geschildert habe, mit dem Veresterungsprodukt der Hexose in Reaktion (Hexose⇌

Glykogenäquivalent beziehungsweise vergärbarer Zucker.) Uebrigens kann, wie ich erwähnte, die Brenztraubensäure auch verhältnismässig leicht mit Hexosediphosphat selbst, beziehungsweise der daraus entstehenden Dioxyacetonphosphorsäure zu Milchsäure und Phosphoglycerinsäure reagieren. Diese Reaktion habe ich hier als (5a) aufgeführt. Die analoge Reaktion fehlt bei der Gärung. Andererseits kommt es auch bei der Milchsäurebildung zur Anhäufung von Hexosediphosphat. Das hat dieselbe Ursache wie dort, nämlich erfolgt aus der Umesterung der Phosphobrenztraubensäure mit Hexose nach der Gleichung (4). Die Weiterreaktion der Glycerinphosphorsäure mit Brenztraubensäure ist nicht extra aufgeführt. Wie ich eingangs geschildert habe, geht sie relativ langsam, aber gerade die Möglichkeit, dass auf diese Weise ebenfalls Brenztraubensäure umgesetzt werden kann und ferner die andere, dass auch die Hexosediphosphorsäure selbst mit Brenztraubensäure in Reaktion tritt, sind zweifellos die Ursache, dass die enzymatische Milchsäurebildung nicht so scharf in verschiedene Perioden zerlegt werden kann wie die entsprechenden Gärungsreaktionen, wo der eigentümliche Gärverlauf im Hefepressaft schon vor 30 Jahren die Aufmerksamkeit der Forscher erregt hat.

Natürlich wollen wir aus diesen Studien im Enzymextrakt auch etwas über den Chemismus der Zelle erfahren, wenn auch die Reaktionen von dem Zusammenhang mit der Muskelfunktion vollständig gelöst sind. Tatsächlich kann man aus diesen Studien gewisse Schlüsse auf die Reihenfolge der Reaktionen im lebenden Muskel ziehen. So konnte K. Lohmann schon vor einigen Jahren, aufgrund des Befundes, dass die Kreatinphosphorsäure nur aufgespalten wird, wenn sie sich mit Adenylsäure zu Adenylpyrophosphat umestern kann, den Schluss ziehen, dass die Aufspaltung des Adenylpyrophosphats bei der Muskelkontraktion der Spaltung der Kreatinphosphorsäure vorhergehen muss.[30]

Wenn wir nun auch durch diese Schlussfolgerung und ebenso auch durch die andern chemischen Befunde noch keinerlei brauchbare Vorstellung gewonnen haben, wie sie mit dem Mechanismus der Muskelkontraktion verknüpft sind, so können wir immerhin die energetische Seite dieser chemischen Reaktionen studieren, da sie ja die Energie für die Muskelkontraktion liefern und letzten Endes daher auch der Wärmebildung des tätigen Muskels zugrunde liegen. Als Beispiel möchte ich nur auf einen Punkt hinweisen. Nach den genauesten Wärmeanalysen von Dr. Hartree, dem Mitarbeiter Professor Hills, gibt es nach Ablauf der eigentlichen Kontraktionswärme (initiale Wärmebildung) in Stickstoff eine kurze negative Wärmephase, also eine Abkühlung vor dem Neuanstieg der Wärme, der sogenannten anaeroben Restitutionswärme.[31] Schon lange beziehen wir diese anaerobe Restitutionswärme auf die nachträgliche Milchsäurebildung, d.h. genauer auf den Ueberschuss der Wärme, der bei der nachträgliche Milchsäurebildung über die negative Wärme der damit gekoppelten endothermen Synthese der Kreatinphosphorsäure auftritt. Ein Teil dieser gekoppelten Reaktion zwischen Milchsäurebildung und Kreatinphosphorsäuresynthese ist aber die von Parnas entdeckte Umesterung der Phosphobrenztraubensäure mit Kreatin, wobei Kreatinphosphorsäure und freie Brenztraubensäure entstehen. Tatsächlich hat nun diese Reaktion, wie ich gefunden habe,[32] eine messbare negative Wärmetönung von —3,000 g cal pro Mol, weil nämlich die Spaltung der Phosphobrenztraubensäure pro Mol etwa 8,000 g cal, die Spaltung der Kreatinphosphorsäure aber etwas über 11,000 g cal Wärme liefert. Trotzdem aber läuft, wie Sie sehen, auch diese endotherme Reaktion freiwillig ab. Diese negative Wärme ist gerade so viel, wie sie aufgrund der zu berechnenden Umsatzgrössen für die negative Wärmephase des Muskels nötig ist. Nun ist es trotzdem nicht zwingend, dass diese Reaktion für die negative Wärmephase verantwortlich ist, aber man sieht, dass uns wenigstens die energetische Seite der hier in Frage stehenden Reaktionen schon etwas zur Deutung des Wärmeverlaufs im lebenden Muskel zu sagen gestattet. Indessen führt dieses auf ein neues Thema, wie die geschilderten einzelnen Intermediärreaktionen der Milchsäurebildung mit den anderen Tätigkeitsreaktionen verbunden sind. Ich zweifle nicht, dass die neuen Einsichten in den feineren Verlauf der Kohlehydratspaltung, die wir in den letzten Jahren gewonnen haben, nicht nur enzymchemisch interessant sind sondern auch für die Physiologie des Muskels und vielleicht auch die Stoffwechsel-Pathologie von Bedeutung sein werden.

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30 K. Lohmann, *Naturwiss.*, 1934, **22**, 409.

31 Hartree, *Jl. of Physiol.*, 1933, **77**, 104.

32 O. Meyerhof u. W. Schulz, *Biochem. Z.*, 1935, **281**, 292.

The Nutritive Value of Soya Bean Oil Cake Protein.

THE nutritive values of the proteins of three important feeding stuffs, *viz*, soya bean cake, linseed cake and corn-gluten, form the subject of a comparative study by K. L. Turk, Morrison and Maynard and are reported in the *Journal of Agricultural Research*, **51**, No. 5. The data show the superiority of the protein of soya bean oil cake over those furnished by the other two. The average coefficients of apparent digestibility for protein were 67·0 per cent. for soya bean cake, 66·3 for corn-gluten, and 63·3 for linseed cake. The lambs under experiment were more efficient in storing protein from the soya bean cake ration than from either of the other rations. The average percentage of protein intake stored was 33·8 for the soya bean cake, 26·5 for corn-gluten and 26·7 for the linseed cake.

Slightly but significantly higher biological values were obtained for the soya bean cake ration, this being 72·8 as against 65·7 for corn-gluten proteins and 67·7 for linseed cake proteins. The experiments were conducted with three growing wether lambs and each of the feeds in question was added to a low nitrogen ration in such amounts as to furnish a protein level of 10 per cent. with approximately 1 per cent. additional protein being furnished by the other ingredients of the ration. All rations were equalised in energy content.

The Influence of Soil Temperature and Maturity on the Incidence of Sunn Hemp and Pigeon Pea Wilt at Pusa.

AT Pusa it has been found that the same fungus *Fusarium vasinfectum* Atkinson produces wilt in both sunn hemp and the pigeon pea. Characteristic differences however are found to exist in the response to soil temperature made by these two crops. (B. B. Mundkur in the *Indian Journal of Agri. Sci.*, 5, Part V.) In both crops, the incidence is favoured by soil temperature, but in the pigeon pea, wilt was favoured by a somewhat high temperature, *viz.*, between 28° C. and 33° C., while in the case of sunn hemp it was a lower temperature that mattered, *viz.*, 17° C. and 29° C. It was noted that the maturity of the plants also exercised some influence on their susceptibility to the pathogen, more plants dying in the earlier part of the growth in the case of the sunn hemp and more of the pigeon pea in the later stage. The simple and multiple coefficients of correlation among the three variables, soil temperature, maturity and wilt incidence, gave significant values indicating that the hypothesis is correct. It was further noted that the values of partial coefficient of correlation between wilt incidence and soil temperature, eliminating the effect of maturity, or between wilt incidence and maturity eliminating the effect of soil temperature, were not significant, showing that the influence of soil temperatures and maturity was a combined one on these crops.

The Propagation of Coffee by Cuttings.

THE obvious advantages of the method of vegetative propagation in the breeding of new varieties of coffee make it worthy of much more attention than it has been receiving so far. The results of a study of the method by Briccio O. Reynoso (abstracted in the *Philippine Agriculturist*, **24**. No. 4) are therefore of much welcome interest. The work related to study (1) coffee propagation by cuttings; (2) the soil medium best suited for rooting coffee cuttings; and (3) to determine the difference between soft-wood cuttings and hard-wood cuttings in their ability to produce roots. In the experiment, 12,000 cuttings of *Coffea robusta* were used; 6,000 were soft-wood cuttings from immature upright branches with green bark and 6,000 were hard-wood cuttings from mature upright branches with brown bark. The soil media used were sand, combination of equal parts of sand and ordinary garden soil, ordinary garden soil and forest soil. Plots were laid down at three stations having different elevations. Leaf counts were made weekly and the root formation was examined after one year of growth. The author found that, (1) under field conditions, the two types of Robusta coffee cuttings produced roots, (2) the soft-wood cuttings required at least three to six weeks to develop leaves and the hard-wood, five to nine weeks, (3) garden soil was the best medium for the rooting of the hard-wood cuttings and sand for the soft-wood, (4) hard-wood cuttings produced more long roots than soft-wood. The recommendation is made that for propagation, hard-wood cuttings from mature upright branches with brown bark are to be preferred to soft-wood cuttings.

Does the Flowering of Sugarcane Injure its Quality?

AN emphatic answer in the negative is furnished by H. N. Batham and L. S. Nigam as the result of their observations at Cawnpore and Shahjahanpur in the season 1931–32 (*Agriculture and Livestock in India*, **6**, Part I). The canes concerned were Co. 213, Co. 281, and Co. 300. The flowering of canes is a rare occurrence in the U. P., but in the season 1931–32 it occurred extensively and was taken advantage of for this study. Their conclusions are: (1) the flowering does not appear to reduce the tonnage nor the quantity of juice but tends to increase both; (2) flowered canes are better in sucrose content than those which are not then in flower to the extent generally of more than one per cent.; (3) the amount of glucose is found to be appreciably less in flowered canes than in unflowered canes; (4) a negative correlation is found to exist between leaf area and the percentage weight of juice expressed; and (5) heavy rainfall combined with high temperature and humidity can induce arrowing in sugarcanes in Northern India. The arrowing studied here appears, however, to have occurred practically at the maturity of the cane, *i.e.*, from about the tenth month or so onwards after planting, a fact which is borne out by the glucose content of the canes, *viz.*, about 0·2 per cent. on the average. The studies also do not indicate if and to what extent cane deteriorates if left to stand after flowering has taken place, and to what length of time it can be so left without serious loss of sugar. The more serious aspect of the problem is not what has happened in the present case but when cane flowers much *before* its period of maturity with the obvious cessation of all further growth and therefore a great reduction in the expected tonnage. The earlier records of the Mysore Department of Agriculture contain somewhat extensive studies of this problem and could have been consulted by the authors with advantage.

An Automatic Respirograph.

ESSENTIALLY on the lines of Bose's Photosynthetic recorder, A. Guha-Thakurta and B. K. Dutt (*Trans. Bose Res. Inst.*, 1933–34, **9**, 77) have developed an automatic apparatus for the measurement of respiration of plants. The respirograph consists of a respiration chamber, a bubbler, an oxygen container and an electro-magnetic recording apparatus. The respiration chamber contains, besides the respiring material, a quantity of NaOH which absorbs the CO_2 evolved, and the decrease of pressure in the chamber due to the absorption of oxygen, causes the lifting of a mercury valve, allowing ingress of a number of bubbles into the respiration chamber. The rate of passage of successive bubbles of oxygen is automatically recorded on a revolving drum by means of an electro-magnetic device. The advantages of the apparatus are that the percentage of oxygen in the respiration chamber is maintained at a constant value and due to the use of an automatic recording equipment all personal errors of observation are eliminated.

Automatic Record of Embryonic Growth of Germination of the Seed.

THE time of initiation of growth of the embryo of the seed as well as its rate have been a matter of speculation. The germination of the embryo starts a considerable time before the external appearance of the radicle subsequent to the rupture of the seed-coat. B. K. Dutt and A Guha-Thakurta (*Trans. Bose Res. Inst.*, 1933–34, **9**, 58) have recorded by means of an automatic device the rate of growth of the radicle before and after the bursting of the seed-coat. Investigations were carried out on the seeds of *Cicer arietinum*, and four phases have been distinguished during early germination: (1) a period of physical expansion or swelling due to the absorption of water lasting for 1·5 to 2·5 hrs.; (2) a stationary phase, lasting from 1–1·5 hours before the initiation of the embryonic growth; (3) the slow growth of the radicle inside the seed for about 10 hours; and (4) the enhanced growth of the radicle following the sudden bursting of the seed-coat. A parallel study was also made of the rate of oxygen absorption during germination. The intake of oxygen began at the initiation of germination inside the seed, there being no oxygen absorption during the swelling of the seeds.

Thelleriasis of Young Calves.

SMEARS from liver and spleen taken during the post-mortem examination on the body of a young calf aged 18 days at the main dairy at Baghdad revealed that 90 per cent. of the red blood corpuscles were invaded by *Theileria annulata* (Machattive, *Indian J. Vet. Sci. and Animal Husb.*, 1935, **5**, 288). Since then enquiries conducted at other dairies revealed that the disease is common.

Only young calves aged about two to three weeks are known to be affected, the infection reaching its height between the 17th and 19th day of life. The period of incubation is usually about 14 days. The real crisis with a temperature of 105°·0 F. to 106°·0 F. lasts from 12 to 24 hours. No appreciable symptoms of disease are usually seen. Important post-mortem appearances are, a marked icterus condition with hæmorrhages on stripping the skin, the characteristically yellow liver and enlargement of spleen to about 5 times its normal size. The mortality among the affected is about 50 per cent., the course of the acute disease lasting about a week ending either in death or in recovery by crisis.

S. D. A.

A Study of Felspar Twinning in a Differentiated Sill.

SOME petrographers have observed from time to time that the different types of felspar twinning are essentially controlled by the composition of the magma, and as a consequence it has been assumed that the pericline type of twinning is commonly noticed in basic rocks and the other type in acid rocks. In order to verify the above conclusion, W. M. Chapman of the Wisconsin University (*American Mineralogist*, **21**, 1) has made a detailed study of the differentiated diabase sill of the Algoma district, Ontario. His study has shown that the number of twins increases with the basicity or the anorthite content of the rock, and that the variation of twinning is due to causes other than the composition of the magma. He has further undertaken the investigation of the causes that control the felspar twinning in granites and gabbros, and interesting results are awaited.

Mitosis in *Amœba*.

J. A. DAWSON, W. R. KESSLER and J. K. SILVERSTEIN (*Biol. Bul.*, 1935, **69**, No. 3, 447-461) have found a number of significant differences in the details of mitotic divisions between *Amœba dubia* and other free living Amœbæ, depending upon fundamental structural differences in the nucleus. In the nucleus of this species no endosome, as has been described for other species, has been found, but the chromatin is evenly distributed throughout the entire resting nucleus. The nuclear membrane never disappears throughout the entire process, both chromatic and achromatic elements of the spindle being derived solely from the nucleus. Another interesting feature is the presence of large achromatic bodies of as yet unknown constitution and function, which appear in large numbers in the early prophase, persist throughout the entire process of fission and gradually disappear in the reconstructing nucleus. The study supports the view that *A. dubius* and *A. proteus* are quite distinct species.

Cytoplasmic Components in Fertilisation.

THE rôle of cytoplasmic inclusions, especially that of the Golgi apparatus and the mitochondria, in fertilised eggs is the subject of a paper by Vines Collier Jr. (*Quart. Journ. Micros. Sci.*, Feb. 1936, **78**, Part III, N. S. No. 311) who gives an accurate picture of the fertilisation processes and the ultimate function of the Golgi and mitochondria. One of the main functions of fertilisation is to deposit in the egg, the acrosome, whose precise function during and after fertilisation, has been a matter of great doubt and diversity of opinion. Collier has determined its function; it gives rise to a number of refringent bodies so characteristic of fertilised eggs of *Ascaris*. At first scattered evenly in the egg, they tend gradually to accumulate towards the periphery and in the opinion of the author contribute to the formation of the thick cell wall of the egg. The Golgi bodies and the mitochondria are at first small and indistinguishable from each other. The Golgi bodies become enlarged and gradually deposit fat within them while the mitochondria remain the same and probably do not undergo any change. The secretion formed by the Golgi bodies is used up by the cell.

Recent Researches in the Theory of Meromorphic Functions with Special Reference to Picard-Borel Theorem.*

Part I.

ONE of the most interesting topics in the theory of functions is that of the distribution of values of an analytic function. The easiest of problems of that nature is the investigation of the nature of the distribution of values of an analytic function in the neighbourhood of an isolated singularity. The distribution of values of $f(z)$ in the neighbourhood of a pole is well known. [$|f(z)| \to \infty$ uniformly as $z \to$ to the pole]. Therefore we need consider only the case of an essential isolated singularity. Weierstrass obtained the first fundamental theorem in this connection. He showed that an analytic function takes values as near as we please to a given value in any neighbourhood of the singularity. Picard showed by using the fundamental properties of the elliptic-modular function that $f(z)$ takes every value with the exception of at most one value. (Note $e^{1/z}$ does exclude the value zero in the neighbourhood of its essential singularity, *viz.*, the origin.) Borel gave an elementary proof of this result and extended this to the case of a singularity which may be a limiting point of poles of the function. (At this stage it is better to consider the singularity to be at ∞.) In such a case we say that the function is meromorphic in the neighbourhood of the singularity. Borel precised this result and was able to show that the *density* of zeros of $f(z) = a$, (we say $f(z)$ is a meromorphic function in case it has no essential singularities other than ∞) was the same for almost all a, in case of meromorphic functions of finite-order. Valiron, Blumenthal and others precised and extended Borel's classical results to the case of meromorphic functions of all orders. But up till the advent of the Finnish School of workers headed by R. Nevanlinna, all the results that were obtained were only the sharpened forms of Borel's results. (For results in other directions see, *e.g.*, Bieberbach-Lehrbuch der Funktionen-Theorie, Bd, II, Auf. II.) R. Nevanlinna introduced the important notion of a defective value and gave a different systematic theory. (See his excellent Borel-tract—*Le theorome de Picard-Borel, etc.*) F. Nevanlinna obtained his brother's results by utilising the theory of modular functions (*Acta Math.*, 1927, **50**). He was able to find out the kernel of the use of the modular function in this theory. (See, *e.g.*, F. Nevanlinna, *Fest-schrift an Lindlöf*, 1930.) Ahlfors gave a very simple and beautiful introduction to the subject recently (*Comm. Soc. Sci. Fenn*, 1935). I propose to develop the main results of the theory by adopting the methods sketched by him.

First of all let us assume that $f(z)$ is a function meromorphic in the whole plane. (The generalisation of the results obtained to the case when $f(z)$ is meromorphic in $|z| > R$ is too obvious. Hence Picard's *great-theorem* is obtained at once from the second fundamental inequality of Nevanlinna obtained here.) Let us project the complex-plane stereographically on a sphere of radius $\frac{1}{2}$, touching the plane at the origin. Let (a, b) denote the distance between the images of a and b on the sphere (actual distance—not the spherical distance). Then

$$(a, b) = \frac{|a-b|}{\sqrt{(1+|a|^2)\ (1+|b|^2)}}$$

with slight modifications when a or b is 0 or ∞. We introduce the two functions

$$m(r, a) = \frac{1}{2\pi}\int_0^{2\pi} \log \frac{1}{(f(re^{i\theta}), a)}\, d\theta.$$

and

$$N(r, a) = \int_0^r \frac{n(r, a)}{r}\, dr,$$

where $n(r, a)$ is the number of zeros of $f(z) = a$ in $|z| < r$ (the zeros being counted according to their multiplicity). It is easily seen that the first function measures the nearness of $f(z)$ to a on the circle $|z| = r$, and the second measures the density of zeros of $f(z) = a$ in $|z| < r$. Then we have the remarkable result of Nevanlinna that the sum of these two functions is independent of a. This function is called the characteristic function of $f(z)$ and is denoted by $T(r)$. This result is derived very simply as follows :

$$m(r, a) - m(r, b) = \frac{1}{2\pi}\int_0^{2\pi} \log\left|\frac{f(re^{i\theta}) - b}{f(re^{i\theta}) - a}\right| d\theta + \text{const}.$$

$$\therefore \frac{dm(r, a)}{dr} - \frac{dm(r, b)}{dr} = \frac{1}{2\pi}\int_0^{2\pi} \frac{\partial}{\partial r} \log\left|\frac{f-b}{f-a}\right| d\theta.$$

$$= \frac{1}{2\pi}\int_0^{2\pi} \frac{\partial}{r\partial\theta} \operatorname{amp}\left(\frac{f-b}{f-a}\right) d\theta$$

$$= \frac{n(r, b) - n(r, a)}{r}.$$

Integrating both sides and incorporating the integration constants in the functions themselves we obtain the first fundamental theorem of Nevanlinna, *viz.*

I. $T(r) = m(r, a) + N(r, b) = m(r, b) + N(r, b)$.

Roughly speaking, we may say that if the density of the zeros of $f(z) = a$ is $<$ that of $f(z) = b$ then $f(z)$ has to incline more towards a than b as $z \to \infty$. There is an interesting property of $T(r)$ (analogous to Hadamard's three circle theorem), *viz.*, it is a convex increasing function of $\log r$. This is proved easily as follows :—

Let $d\omega(a)$ be the surface element at the point on the sphere corresponding to a on the complex plane. Then multiplying by $d\omega(a)$ and integrating I we have

$$\pi\ T(r) = \int m(r, a)\, d\omega(a) + \int N(r, a)\, d\omega(a)$$

*Abstract of lectures delivered by K. Venkatachaliengar to the Central College Mathematical Society, Bangalore.

where $\int$ means that it is integrated over the sphere. As the distance between any two points on the sphere is $\leqslant 1$, $m(r, a)$ is +ve. Now

$$\int m\,(r, a)\, d\omega\,(a) = \frac{1}{2\pi}\int_0^{2\pi} d\theta \int \log \frac{1}{(a, f)}\, d\omega\,(a)$$

by changing the order of integration,

but $\int \log \frac{1}{[a, f\,(re^{i}\theta)]}\, d\omega(a)$ is certainly independent of $f\,(re^{i}\theta)$ [on account of the symmetry of the sphere].

$$\therefore \mathrm{T}\,(r) = \int_0^r \frac{dr}{r} \int n\,(r, a)\, d\omega\,(a) + \text{const.}$$

$$= \int_0^r \frac{\mathrm{S}\,(r)}{r}\, dr + \text{const.—say, where } \mathrm{S}(r)$$

is easily seen to be positive (and increasing). Hence

$\mathrm{T}'\,(r) = \frac{\mathrm{S}\,(r)}{r}$. Hence T (r) is a convex increasing function of log r.

To illustrate the first fundamental theorem we take an example [*cf.* Nevanlinna, *loc. cit.*], Suppose $f(z) = \int_0^z e^{-t^2}\, dt$. Then we easily deduce the following formulæ. $m\,(r, \infty) = \frac{r^2}{\pi}\,[1 + \epsilon\,(r)]$, $\epsilon\,(r) \to 0$ as $r \to \infty$. $\mathrm{N}\,(r, \infty) = 0$.

$\therefore \mathrm{T}\,(r) = \frac{r^2}{\pi}[1 + \epsilon\,(r)]$. It is also proved easily that $m\left(r, \pm \frac{\sqrt{\pi}}{2}\right) = \frac{r^2}{2\pi}\,[1 + \epsilon\,(r)]$, and for any other value of a, $m\,(r, a) = 0$. Hence we deduce from I, the following information about the density of roots of $f\,(z) = a$, *viz.*,

$$\mathrm{N}\left(r, \pm \frac{\sqrt{\pi}}{2}\right) = \frac{r^2}{2\pi}\,[1 + \epsilon\,(r)]$$

and $$\mathrm{N}\,(r, a) = \frac{r^2}{\pi}\,[1 + \epsilon\,(r)].$$

In this typical example we notice the following excepting for the values ∞, $\pm \frac{\sqrt{\pi}}{2}$, $\frac{\mathrm{N}\,(r, a)}{\mathrm{T}\,(r)} \to 1$.

If we define $\delta\,(a)$, the defect of a by

$1 - \varliminf_{r \to \infty} \frac{\mathrm{N}\,(r, a)}{\mathrm{T}\,(r)}$, then $\delta(\infty) = 1$, $\delta\left(\pm \frac{\sqrt{\pi}}{2}\right) = \frac{1}{2}$.

$\Sigma\,\delta(a)$ is called the total defect of $f(z)$, and a value for which $\delta(a) > 0$, is called a defective value. Precise information about questions of this nature are obtained by the second fundamental theorem of Nevanlinna. From this Nevanlinna has obtained that the aggregate of defective values is enumerable and the total defect is at most 2. (This is the best possible result, *e.g.*, consider e^z, then $\delta(0) = \delta(\infty) = 1$.)

Now we come to the proof of the second fundamental theorem of Nevanlinna. Let $\rho\,(a)$ be a positive density function defined on the sphere, (a is a point on the complex plane), such that the total density is unity. Let us denote for simplicity the surface element on the sphere corresponding to the image of a on the sphere by $\overline{da}$. Multiplying by $\rho\,(a)$ and integrating I, we obtain

$$\mathrm{T}\,(r) = \int m\,(r, a)\,\rho\,(a)\,\overline{da} + \int_0^r \frac{dt}{t} \int n(t, a)\rho(a)\overline{da}$$

as the first term on the right is always +ve.

$$\mathrm{T}\,(r) > \int_0^r \frac{dt}{t} \int n(t, a)\,\rho\,(a)\,\overline{da}.$$

We shall interpret $\int n(t,a)\,\rho\,(a)\,\overline{da}$. It means that at every point in $|z| < t$ at which the function takes a value a (for every a), a small element of area around it is transformed by means of $f(z)$ and then this element is projected on to the sphere. *i.e.*, it is the *weighted* area of the total Riemannian-sphere of $f(z)$ for the area $|z| \leqslant t$. We can obviously calculate the area in another way and obtain

$$\int n\,(r, a)\,\rho\,(a)\,\overline{da} = \int_0^t u du \int_0^{2\pi} \frac{|f'\,(ue^{i}\theta)|^2}{[1 + |f(ue^{i}\theta)|^2]^2}\, d\theta.$$

Let us introduce the symbol $\lambda\,(u)$, for the integral *w.r.t.* θ on the R.H.S. Finally we obtain

$$\mathrm{T}\,(r) > \int_0^r \frac{dt}{t} \int_0^t \lambda\,(u)\, u du.$$

This shows that T (r) is probably of the same order as $\lambda(r)$. We shall prove that excluding certain intervals, whose total length is finite $\log \lambda(r) = 0\,[\log \mathrm{T}(r).\, r]$. Suppose in an interval $\mathrm{I}_1 = (a, b)$, (1) $\lambda\,(t) > \frac{[\mathrm{A}\,(t)]^{1+\epsilon}}{t}$

where $\epsilon > 0$, and $\mathrm{A}\,(t) = \int_0^t \lambda\,(u)\, u du$,

$\therefore$ A(t) monotonically increases; and

$$\mathrm{A}'\,(t) = t\,\lambda\,(t).$$

$$\therefore \frac{\mathrm{A}'\,(t)}{[\mathrm{A}\,(t)]^{1+\epsilon}} = \frac{\lambda\,(t)}{\epsilon\,[\mathrm{A}\,(t)]^{1+\epsilon}} > 1.$$

Integrating this we obtain

$$\frac{1}{\epsilon}\left[\frac{1}{[\mathrm{A}\,(a)]^{\epsilon}} - \frac{1}{[\mathrm{A}\,(b)]^{\epsilon}}\right] > \int_{\mathrm{I}_1} dr$$

Writing such inequalities for all intervals, in which (1) is true and summing up, (as the series on the left is convergent) we obtain that the sum of the lengths of such intervals is finite. Similarly if

$$\mathrm{B}\,(t) = \int \frac{(t(\mathrm{A})}{t}\, dt.$$

Then excluding a set of intervals whose total length is finite $\mathrm{A}(t) < t\,[\mathrm{B}(t)]^{1+\epsilon}$. Combining the two and noting that $\mathrm{T}(r) > \mathrm{B}(r)$ we obtain that $\log \lambda(r) = 0\,(\log r + \log \mathrm{T}(r)]$. From this we derive an inequality due to Ahlfors.

$$\frac{\lambda(r)}{2\pi} = \frac{1}{2\pi}\int_0^{2\pi} \frac{|f'|^2}{[1+|f|^2]^2}\rho(f)\,d\theta.$$

But as $\log x$ is concave towards the X-axis, we have

$$\log\frac{\lambda(r)}{2\pi} \geqslant \frac{1}{2\pi}\int_0^{2\pi} \log\frac{|f'|^2}{[1+|f|^2]^2}\,d\theta$$

$$+ \frac{1}{2\pi}\int_0^{2\pi} \log\rho(f)\,d\theta.$$

Denoting the first integral on the R. H. S. by $2\mu(r)$, we obtain

$$\mu(r) = \frac{1}{2\pi}\int_0^{2\pi} \log|f'|\,d\theta - \frac{1}{\pi}\int_0^{2\pi}\log[1+|f|^2]^{\frac{1}{2}}d\theta.$$

$$= \frac{1}{2\pi}\int_0^{2\pi} \log|f'|\,d\theta - 2\,m(r,\infty).$$

$$\therefore \mu'(r) = \frac{1}{2\pi}\int_0^{2\pi} \frac{\partial}{r\partial\theta}\operatorname{amp} f'\,d\theta - 2.\frac{dm(r,\infty)}{dr}.$$

The first expression on the R. H. S. is the difference between the zeros and poles of $f'(z)$ in $|z| < r, \div r$. Denoting the corresponding functions of the derivate $f'(z)$ by n_1, N_1, etc., and integrating, we obtain

$$\begin{aligned}\mu(r) &= N_1(r,0) - N_1(r,\infty) \\ &\quad - 2[T(r) - N(r,\infty)] \\ &= [N_1(r,0) - N_1(r,\infty) + 2N(r,\infty)]. \\ &\quad - 2T(r).\end{aligned}$$

Denoting the expression in the brackets by $\overline{N}(r)$ we obtain Ahlfors's inequality

$$\text{II}'.\quad \frac{1}{2\pi}\int_0^{2\pi} \log\rho(f)\,d\theta \leqslant 4T(r) - 2\overline{N}(r)$$

$$+ \log\frac{\lambda(r)}{2\pi}.$$

The last term on the right is of $0(\log r\ T(r))$ except in the exceptional intervals (to be always understood in what follows). We call $\overline{N}(r)$ the branch-function. If $\overline{n}(r)$ is the number obtained by counting the multiple roots of $f(z) = a$, for all a, in $|z| < r$, counting them, a number of times equal to their order of multiplicity decreased by unity, then a little calculation will show that

$$\overline{N}(r) = \int_0^r \frac{\overline{n}(r)}{r}\,dr$$

—hence is a positive increasing function of r.

From II′ we derive Nevanlinna's second fundamental theorem by taking a suitable density-function ρ. Let $a_1, a_2, \ldots\, a_q$ be any q values. Let $\rho(f)$ be defined by

$$\log\rho(f) = 2\sum_1^q \log\frac{1}{[f,\ a_\nu]}\ \ldots.$$

$$\ldots.\ -\beta\log\left[\sum_1^q \log\frac{1}{[f,a_\nu]}\right] + C$$

where C is the constant introduced in order to ensure that the total density is unity. If $\beta > 1$ it is easily seen that $\int\rho(a)\,\overline{da}$ is convergent. Substituting this in II′ we obtain

$$\frac{1}{\pi}\int_0^{2\pi} \sum_1^q \log\frac{1}{[f,a_\nu]}\,d\theta$$

$$-\frac{\beta}{2\pi}\int_0^{2\pi} \log\left[\sum_1^q \log\frac{1}{[f,a_\nu]}\,d\theta + C\right.$$

$$\leqslant 2[2T(r) - \overline{N}(r)] + 0[\log r.\,T(r)].$$ The coefficient of β on L. H. S. $\leqslant \log \frac{1}{2\pi}\int_0^{2\pi}\sum_1^q$

$$\log\frac{1}{[f,a_\nu]}\,d\theta = \log\left\{\sum_1^q m(r,a_\nu)\right\}.$$

Hence

$$\sum_1^q m(r,a_\nu) \leqslant 2T(r) - \overline{N}(r) + \log\sum_1^q T(r)$$
$$+ 0[\log r\ T(r)]$$

as $T(r) > m(r,a_\nu)$. Substituting $T(r) = m(r,a_\nu) + N(r,a_\nu)$ on the L. H. S., we obtain Nevanlinna's second fundamental theorem

$$\text{II.}\ (q-2)\,T(r) < \sum_1^q N(r,a_\nu) - \overline{N}(r) +$$
$$0[\log r,\ T(r)].$$

[$q > 2$ obviously.]

From this Picard's theorem is obtained immediately. For if a meromorphic function does not take three values say a_1, a_2 and a_3, then taking $q = 3$ and these values in II we obtain that

$$\overline{\text{Lim}}\ \frac{T(r)}{\log r} < k \text{ (a finite constant).}$$

$\therefore \dfrac{N(r,a)}{\log r} < k$ for all r and a. From this we immediately deduce that $n(r,a)$ is finite—*i.e.*, the function takes all values only a finite number of times. In that case it should be a rational function. (For this simple result see, *e.g.*, *Bieberbuch-Funktionen-theorie*, Bd. I., Auf. III.) But then it cannot exclude more than one value. Hence the number of lacunary values of $f(x)$, *i.e.*, the values which are taken by $f(z)$ only a finite number of times should be at most equal to 2. (Note that we could have derived all our results on the supposition that $f(z)$ was meromorphic in $|z| \geqslant R$ instead of in the whole plane; hence Picard's *Great Theroem* is also at once obtained.

Now Nevanlinna has deepened Picard's theorem in this way—*i.e.*, The total defect of a meromorphic function is at most equal to 2. Let

$$b(f) = \underline{\text{Lim}}\ \frac{\overline{N}(r)}{T(r)}$$ be named the branch-index of the function. Then dividing both sides of II by $T(r)$ we obtain $\sum_1^q \delta(a_\nu) + \epsilon(f) \leqslant 2$. This is

true for any q and hence the total number of defective values is enumerable and the total defect + the branch-index, never exceeds 2. (As mentioned earlier 2 is the best possible constant.) In this connection Nevanlinna has conjectured that the total number of defective values in the case of a meromorphic function of finite order [*i.e.*, if $\frac{T(r)}{r^\rho}$ is finite for some ρ], then the number of defective values also is finite. This is as yet unproved.

From II we can deduce theorems concerning multiple values. a_1, is said to be a multiple value of $f(z)$ if (2) $f(z) = a_1$, has always multiple roots. Its order m_1 is the least possible order of the roots of (2). (It is obviously $\nless 2$.) If a_1, a_2, a_3 are multiple values with multiplicity m_1, m_2, m_3, respectively we obtain from II,

$$T(r) \leqslant \sum_1^3 [N(r, a_\nu) - \frac{m_\nu - 1}{m_\nu} N(r, a_\nu)] + 0 [\log r \, T(r)]$$

by taking into accouut $\overline{N}(r)$.

$$\therefore T(r) < T(r) \sum_1^3 \frac{1}{m_\nu} + 0 [\log r . T(r)]$$

$$\text{as } T(r) > N(r, a_\nu).$$

$$\therefore \frac{1}{m_1} + \frac{1}{m_2} + \frac{1}{m_3} \geqslant 1.$$

(We shall exclude the case of a rational function as direct analysis is possible in that case.) Similarly we obtain that

$$(3) \quad \frac{1}{m_1} + \frac{1}{m_2} + \frac{1}{m_3} + \frac{1}{m_4} \geqslant 2 \text{ and}$$

$$(4) \quad \frac{1}{m_1} + \frac{1}{m_2} + \frac{1}{m_3} + \frac{1}{m_4} + \frac{1}{m_5} \geqslant 3;$$

but $m_r \geqslant 2$. Hence from (4) we deduce that there cannot be more than four multiple values for a meromorphic function. This is really the best possible constant. For the Weierstrassian elliptic function $p(z)$ is such that it takes the values e_1, e_2, e_3 and ∞ always with multiplicity 2.

Conversion of Coal into Oil.*

A REPORT issued by the Department of Scientific and Industrial Research reveals that the process which forms the basis of the big coal-into-oil plant recently opened at the Imperial Chemical Industries Works at Billingham, was first discovered by Bergius in Germany as the result of applying hydrogen under pressure to "Artificial Coal" produced by him from cellulose and peat. The *Report* makes public for the first time the results of many early experiments on the conversion of British coals into oil and describes how the British Government, acting through the Department of Scientific and Industrial Research and its Fuel Research Board, ensured the development of the process covered by the Bergius patents.

The *Report* makes it clear that in view of the great importance of securing adequate oil supplies from British coal, the department considers it highly desirable that the knowledge gained in every stage in the development of this epoch-making process should be fully available to British technicians.

Via "ARTIFICIAL COAL" TO OIL.

Bergius, the *Report* states, as early as 1910 had evolved apparatus for working under high pressures and after studying a number of other reactions he heated cellulose and peat in the presence of water to 340° C. at a pressure of 150 atms. The products were black solids which he considered similar to natural coal and which he called "artificial coal". Later Bergius turned his attention to heavy petroleum oils which, when heated under pressure in hydrogen, gave a quantity of light spirit. On treating his artificial coals in a similar manner, Bergius obtained a 70 per cent. conversion into oil soluble in benzene. Natural coals were then found to behave similarly, and in 1914 Bergius patented the application of the process to coals and other solid carbonaceous substances.

EARLY EXPERIMENTS AT THE FUEL RESEARCH STATION.

Further development was delayed during the War and, owing to the cost of high pressure work, little was done until 1921 when a plant on a semi-industrial scale was erected at Mannheim-Rheinau in Germany for treating oil. Research on the process was also initiated at the Fuel Research Station, Greenwich, in 1923 with a small home-made converter. From the experiments there, it was satisfactorily established that the Bergius process afforded a means of obtaining much higher yields of benzene soluble material from coal than were obtainable by any other known method.

BRITISH COALS TESTED IN GERMANY.

In 1924, the British Bergius Syndicate was formed which obtained an option on the patent rights of the Bergius process covering the British Empire, and experiments were carried out at Mannheim-Rheinau to test the suitability of British coals for the process. The preliminary results obtained were favourable and were communicated to the British Government. In view, therefore, of the importance of any practical means of obtaining liquid fuels from British coals, it was decided that the Department of Scientific and Industrial Research should proceed with the investigations. An agreement was accordingly entered into between the Department, the British Bergius Syndicate, the Internationale Bergin Compagnie and Dr. Bergius whereby the option on the patents which were shortly running out was continued. Further experiments were carried out at Mannheim-Rheinau in Germany on British coals.

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*Fuel Research Technical Paper. No. 42—"The Action of Hydrogen on Coal. Part II. Early Experiments with the Bergius Process." Published by H. M. Stationery Office. 1/3*d*. net.

These experiments were supervised by a Committee consisting of two representatives of the Department, two representatives of the British Bergius Syndicate and Dr. Bergius and in them trials were made with coals from various parts of the country in small converters while "Orgreave Washed Slack" obtained from South Yorkshire was selected as a suitable coal for tests in a continuously operated plant. The results were again promising and a plant enbodying the latest improvements resulting from the work in Germany was supplied to the Fuel Research Station. This plant was installed towards the end of 1926 and in 1927, the small-scale experiments carried out at Rheinau were terminated by agreement and the work continued at the Fuel Research Station.

DESCRIPTION OF THE EARLY EXPERIMENTS.

The *Report* in describing the process as evolved originally by Bergius states that his converters were at first glass lined, and then made of plain steel. They were rotated about a horizontal axis, with pebbles within to assist stirring; about 100 atms. was the working pressure, and they were heated externally, either by gas or electricity, for about one hour. After removal, the products were distilled and treated by benzene extraction, the material so recovered being known as "oil". At a later stage in the evolution of his process, Bergius added oil to the charge, at first to avoid local overheating, and later to help in the working of a continuous plant into which a mixture of coal and oil could be pumped in the form of a paste. A further modification was the addition of a proportion of luxmasse, which consists largely of iron oxide with some alumina and titanium, to the charge in order to fix the sulphur in the form of iron sulphide. From subsequent researches at the Fuel Research Station, it was established that the luxmasse had also a definite catalytic effect in hastening the hydrogenation of the coal, contrary to the statements of Bergius.

Other British coals from the Nottingham and Derby, South Yorkshire and Durham coalfields were then tried, generally with satisfactory results. In the course of the work at the Fuel Research Station, the early stages of the reaction were studied and it was discovered that below the temperature of 450° C. normally employed by Bergius, the coal underwent marked changes. Thus, at about 370° C. in the case of a bituminous coal, reaction between the coal and hydrogen took place rapidly and resulted in the formation of a plastic material. If the products were allowed to cool immediately after reaching this temperature a solid product was obtained which had every appearance of having been through a fluid condition. This solid product, which was almost equal in weight to the original coal, had higher coking properties than the coal used in the experiment.

The continuously operated plant at Mannheim-Rheinau consisted of two horizontal reaction vessels in series, contained in baths of molten lead, heated by gas, and fitted with simple mechanical stirrers. A paste consisting of tar, coal and luxmasse was forced through these vessels, with hydrogen, at 150 atms. pressure. Various modifications were tried and numerous tests carried out with varying success, details of which are given in the *Report*.

The equipment which was installed at the Fuel Research Station as a result of the work is also fully described. It provided a continuously operating plant capable of dealing with a ton of coal a day, embodying all features of the latest practice, at the time of erection, of the Bergius Research Institute, together with an adequate plant for making hydrogen.

This plant was used originally for studying Parkgate coal from South Yorkshire and later coals containing less ash, namely, coal from the virgin Seam, Lanark, and finally Beamshaw coal from Wakefield.

The Classification of the Archæan Rocks in India.

A SYMPOSIUM on the Classification of the Archæan Rocks in India was held at a meeting of the Geology and Geography Section of the Indian Science Congress (Indore, 1936) under the Chairmanship of Mr. B. Rama Rao, M.A., D.I.C., F.G.S., the President of the Section.

The President in his introductory remarks pointed out that there was no general agreement among the several workers in the Archæan tracts of India regarding the classification and correlation of these ancient rocks. He stated this disagreement was in no small measure due to the fact of the scattered occurrences of the Archæan rocks in widely separated areas with the intervening distances between them being so large as to make it almost impossible for any single field geologist to get a personal acquaintance with the typical characteristics of each of such separate regions. He requested Sir Lewis Fermor who had devoted more than 30 years of his life for an intimate study of many of the Archæan tracts of India, to lead the discussion by giving an account of his views on the subject.

SIR LEWIS FERMOR opened his observations by a reference to his *Memoir* on the Archæans of India, which he said was in the Press and would be issued soon. He stated that he had divided therein the Archæans of the Peninsular India into two main provinces: the Charnockitic and the non-Charnockitic and had brought together the various formations of the different regions under that grouping. These major provinces were further sub-divided into minor provinces on the strength of lithological characters and associated ore deposits. Thus, in the non-Charnockitic Province, 10 sub-divisions, *viz.*, 3 iron ore Provinces of Singhbhum, Mysore, etc., 3 marble Provinces of Nagpur, Balaghat, Narbada and Son Valleys, etc., and 4 Igneous Provinces of Hyderabad, Bundelkhand, Shillong, etc., were grouped. In the Charnockitic Provinces, 18 sub-divisions were grouped under the Garnet, Iron ore and Manganese Provinces.

Speaking on the correlation of the Archæans Sir Lewis referred to some of the general features which had been dealt with in his Presidential Address to the National Institute of Sciences of India and also in the Introductory chapter of his *Memoir* which was in the Press. Referring to certain details of correlation, he stated that the recent work of Dr. Krishnan had shown that the Gangapur series of the Bihar and Orissa were the equivalents of the Sausar series of the C.P. He regarded the Kodurite series as hybrid igneous rocks with the Gondite series and pointed out the possibility of establishing an acceptable correlation by using the Gondite datum-line. The Dharwars of Mysore appeared to him to be more or less akin to the Sakoli series of the C.P. and the Sakarsanhalli series suggested a relationship to the Gondite series. However, the authors of a recent Bulletin on the subject of origin and correlation of the Sakarsanhalli series had not accepted the correlation with the Gondites and they had only shown them to belong to the Dharwars.

The Khondalites represented a higher grade of metamorphism and in the eastern ghat region, Sir Lewis considered the Khondalites to have been once formed in a deeper zone and subsequently uplifted. Portions of Malabar and Travancore had also the Khondalites and Charnockites.

In concluding his remarks, Sir Lewis pointed out the uncertainty of correlations in the Archæans of the Extra Peninsular India.

MR. D. N. WADIA spoke about the Archæans of the North-Western Himalayas. He stated that the Archæan rocks there occupied tracts of northern Hazara, Indus-Kohistan, Gilgit, Ladakh and the Zanskar range. The granites and gneisses of those areas were considered by Stoliczka and Lydekker to be Archæan (Central Gneiss), while the phyllites and schists were regarded as metamorphosed older Palæozoics. McMahon had established the intrusive nature of much of the Central Gneiss and he believed they were of considerably later age ranging from Palæozoic to Tertiary. Since 1928, the speaker had been working in the crystalline area of the Hazara-Kashmir syntaxis and the results of his field-work tended to prove that the Archæans (Dharwars) of that part of the Himalayas were largely of sedimentary origin. These rocks which had been named the Salkhala series closely resembled the Jutoghs of Simla Hills. The unconformable relations of the Salkhalas to the *puranas* and the fossiliferous Cambrians were observed in some sections. The gneissification of the Salkhalas at many places and the wide prevalence of later intrusive granite gneiss in the Central axial ranges made it difficult to separate any remnants of the Archæan gneisses in the Complex. The Great Himalaya Range west of Ladakh was found to be largely constituted of the Salkhalas converted into paragneiss and the Nanga Parbat (26,620') massif was almost wholly built of those rocks with intrusive biotite-granite of Palæo-Mesozoic age and hornblende-granite injections of post-Eocene period. South of that Range, the Salkhalas showed a steadily decreasing grade of metamorphism and some of the rock elements showed remarkable resemblance with the Dharwar rocks of Rajputana and Singhbhum. Mr. Wadia thought it probable that the Great Himalaya Range represented the basement of the ancient Peninsular Archæans on which the Tethyan sediments were laid down. It thus denoted the Himalayan protaxis.

The speaker said that there were no Archæan outcrops between the Aravalli and the Kashmir Himalayas, except the few straggling hillocks of Kirana and Sangha, which probably represented the unburied peaks of a suspected ridge buried under the Punjab alluvium.

MR. W. D. WEST spoke on the difficulty of bringing the Archæans of the Rajputana into the "picture". Dr Heron's work had shown that the Bundelkhand gneiss was older than the Aravalli series which represented the lowest division corresponding to the Dharwars. Elsewhere, in the Peninsular India, none of the gneisses were definitely established to be older than the Dharwars. There was also some difficulty in fitting up the Archæans of the Peninsular India with Dr. Heron's classification in Rajputana. If the Sausar series of the C.P. were to be correlated with one of the three metamorphosed sedimentary systems in Rajputana on lithological grounds, it was clear that they bore most resemblance to the Delhi system. But the fact that manganese occurred in the Champaner series—which was the same as the Aravalli system—equally well suggested the correlation of the latter with the Sausars though the two were not alike lithologically. Whether the classifications fitted up properly or not, the probability of the Aravalli strike in S.-E. Rajputana curving round so as to join up with the E.W. strike of the C.P. remained clear.

Referring to Sir Lewis' remarks on the tectonic position of the Eastern Ghat Charnockitic province, Mr. West enquired whether there was any progressive change in the metamorphic grade within the non-Charnockitic province proceeding away from the eastern area and if such a change could be shown to exist, he thought it probable that tilting rather than faulting had occurred.

Mr. West also alluded to Auden's work in the Himalayas, which had shown the existence of the Archæans there with the Aravalli strike.

MR. D. S. BHATTACHARJEE spoke on his recent work in the East Bhandara, C.P., which disclosed certain interesting features and which were very suggestive to him in solving the problem of the classification of the Archæans of India. Mr. Bhattacharjee stated that the tract was bounded by rocks with the three regional strikes, *viz.*, the Satpura, Eastern Ghat and Godavari strikes and itself showed numerous evidences of balancing of the directed pressures responsible for these strikes. In the deeper vertical zones of metamorphism, granite-like rocks with what could be described as "Triangular foliation" were developed; while in the higher zones, foliated rocks closely resembling the Sausars, Sakolis, Cuddapahs, etc., were found. According to him, those rocks were mere metamorphic variants of one and the same group of rocks involved in different proportions and altered under different conditions at different periods of time.

The speaker thought that the studies in the Archæans of India had so far been almost wholly confined to Belts characterized by effects of singularly dominant directed pressures and that was probably the reason for the general disagreement of the various investigators on the method

of classification of these rocks. It appeared to him very likely that when the large tracts outside those belts would be examined, many zones of balanced directed pressure might be found and that the study of such areas might throw more light on that highly controversial subject.

MR. M. B. RAMACHANDRA RAO spoke on the metamorphic rocks of the Sakarsanhalli area (in Mysore) which had figured rather prominently in the correlation of the Archæans. The results of detailed mapping and examination of this belt had already been published in a *Bulletin of the Mysore Geological Department*. The rocks occurred as small included patches and lenticular bands along with the hornblende schists in the intrusive granitic gneisses and the speaker was indebted to the President of the meeting for having suggested a possible stratigraphic sequence which could be deduced from the geological section given in the *Bulletin* referred to. According to that view, the metamorphic rocks of Sakarsanhalli appeared to dip underneath the hornblende schists but whether the stratigraphic relation could be actually established or not was left entirely to future work.

Regarding the correlation of the rocks with the Gondites, the speaker said that nothing further could be definitely stated. The manganese garnet of Sakarsanhalli had raised some discussion and had been commented upon by Sir Lewis Fermor who showed its relationship in composition to the garnets from the Gondite-Kodurite series. Originally, the analysis of the Sakarsanhalli garnet had been interpreted rather differently since it was neither so highly manganiferous as the Gondite garnets nor so highly calcic as the Kodurite garnets. The CaO in the particular specimen had been treated as rather exceptional but the comparison instituted then had no implication of correlation. However, subsequent to Sir Lewis' paper on the Manganese-Lime series of garnets, the speaker was engaged in studying some of the published analyses of many garnets from various parts of the world and the inspection of these analyses had shown him that a few of the garnets from extra-Indian localities could easily be shown to lie within the Gondite-Kodurite garnet field plotted in Sir Lewis' diagram, though the typical Manganese-Lime series appeared to be rather rare outside India. The subject was under further investigation and he hoped that Sir Lewis' view regarding the importance of the peculiar metamorphic associations in correlation problems would ultimately prove possible to be established.

DR. S. K. ROY remarked that Sir Lewis' suggested classification of the Archæans into two main provinces and their further sub-divisions was most interesting and hoped that further investigation by Indian petrologists would prove the validity of Sir Lewis' classification. The speaker, with his staff and students of the Indian School of Mines, had carried out some detailed mapping and petrological investigations of the Dharwars round the Jharia Coal Field and the Mica Mines of Kodarma during the past eight years. Those areas were, however, "little" in comparison with those with which Sir Lewis or Messrs. Wadia, West or Rama Rao were acquainted with and on the experience of which they had based their classification. But, so far as the work carried out by the speaker and his associates was concerned, they had found Grubenmann's system of classification and general nomenclature of metamorphic rocks quite satisfactory. Grubenmann had proposed to group the Kristallemmenscheifer into twelve groups, while Sir Lewis grouped the Indian metamorphics into 18 provinces. Grubenmann's classification was followed now-a-days in many parts of the world and the speaker believed that although the 18 groups of Sir Lewis showed individual provincial characters—which were, of course, somewhat different from what was usually understood by the provincial characteristics of igneous rocks—ultimately many of the rocks of those provinces might be fitted up with Grubenmann's classification. The speaker thought, for that purpose, careful chemical analyses, calculation of the Niggli values of those analyses and the projection of their various ratios on the Niggli-tetrahedrons, were necessary. Those data would not only determine the original igneous or sedimentary nature of the rocks but also the positions of the latter in Grubenmann's scheme would be made clear.

As suggested by Sir Lewis himself in his Presidential Address to the National Institute of Sciences, Dr. Roy thought it would be better to follow as far as possible Grubenmann's classification of the metamorphic rocks to classify the Archæan rocks of India with, however, occasional modifications to meet the local needs.

SIR LEWIS FERMOR then replied to some of the questions which had been put to him. In reply to Dr. Roy's remarks, he stated that his classification of the Archæans into the Charnockitic and non-Charnockitic Provinces and their further subdivisions were based on a different conception altogether and had no specific relation to Grubenmann's scheme.

The President thanked the several speakers for their valuable contributions to the discussion and concluded the proceedings with the following remarks :—

"The problem no doubt presents considerable difficulties. A good deal of intensive field work in the several regions of Archæan rocks and a careful co-ordination of the results of such work are still necessary before any final solution could be reached. The classification of the Archæan tracts into provinces and sub-provinces based on mineralogical constitution and the association of epigenetic ores will undoubtedly help to split up the complex formations into convenient sections, but for purposes of correlation of the different isolated formations, it will have to be verified and supplemented by intensive petrogenetic studies of many of the apparently allied types. The correlation of disconnected formations of Archæan rocks of widely separated areas on the basis of the occurrence of any particular lithological type as a recognisable datum-line is not always reliable. But still, in the case of the Archæan rocks several clues will have to be followed and the publication of Sir Lewis' *Memoir* will be eagerly awaited by all students of Archæan Geology to see the lead Sir Lewis gives for amplified application of his line of study.

"Mr. Bhattacharjee's startling inference that the granitic rocks with 'triangular foliation' and the rock groups described as the Sausars, Sakolis and Cudappahs in the Central Provinces, are the resultants of directed pressure of one

and the same mass of granitic material along different zones in a vertical column is not likely to find favour with other geologists acquainted with the region. It is not unknown that in the Archæan Complex, rocks of different modes of origin, involved in various processes of alterations have been rendered almost alike to outward appearance, and the task of the field geologist is, if possible, to sort them out from such confused jumble. In the Archæan complex of Mysore, which had been believed till now to have consisted almost entirely of igneous material, rocks of clearly recognisable sedimentary features are being traced and therefore considerable caution will be necessary before any extreme views could be formulated regarding the genesis of these complex formations. Attempts have been frequently made to classify the Archæan rocks into different groups based on lithological characters, but the question as to how far the crystalline schists as exposed in the several parts of India could be constituted into separate stratigraphic divisions in each of such regions, on the recognition of reliable evidences of break, seems to me to merit further detailed investigation. This involves a more intensive field study of the several exposures of conglomerates which might be found in the different regions of the Dharwar schists. I have already stated in my address that in Mysore from amidst the confusing types of 'conglomeratic rocks' of diverse modes of origin, two clearly marked horizons of what could be regarded as *basal* conglomerates are recognisable in the belts of Dharwar schists. The older set is characterized by the occurrence of pebbles of only quartzites whereas the younger contains in addition pebbles of granitic rocks, suggesting thereby the probability of some of the granites being really older than a section of the crystalline schists which are all at present grouped as one unit.

"This fact of the probable existence of a granitic series older than a section of the crystalline schists included under the Dharwars, leads me to offer a few remarks on the still controversial stratigraphic position of the Aravalli and the Delhi systems in the Archæan rocks of India. I am personally unacquainted with much of these formations and if I venture to offer any remarks they may be regarded more as suggestions than as positive statements. The Aravallis of Rajputana and the Champaner series of Gujerat seem to be now regarded as of one and the same formation. When I had an opportunity of making a hurried study of the latter as exposed in the southern parts of the Bariya State, I got the impression that portions of the Champaner series resembled very much in appearance the rocks of the 'upper division' of the Dharwar schists of Mysore, and also that the quartzites and shales exposed further north forming a major portion of the State bore a striking resemblance to the recorded descriptions of the Idar Quartzites and Phyllites of Mr. Middlemiss, and parts of the Delhi Quartzites of Dr. Heron. Between the typical Champaner beds and those quartzites there is a zone of conglomerate which at the time when I examined struck me to be autoclastic, but whether it is so or not needs verification by closer investigation and detailed mapping. At any rate, in that region, the typical Champaner beds come in contact with the series of quartzites and shales or phyllites, comparable in character to the types described as forming parts of the Delhi Quartzites. All these formations bear a close resemblance in their lithological character to corresponding types of the middle and the upper divisions of the Dharwar schists of Mysore in accordance with the classification I have tentatively proposed in my address. On the strength of the occurrence of a series of granites older than a portion of these crystalline schists, it would be a point for consideration, if parts of the formations now classified as Aravallis, Champaners and the Delhi Quartzites, may not correspond to the "upper division" of my classification of the Dharwar schists of Mysore.

"Let me also say a few words regarding the Sakarsanhalli series of Mysore. This series seems to have attained more prominence for purposes of correlation than what the actual facts warrant. The Sakarsanhalli rocks form a series of a few insignificant outcrops scattered about in the granitic gneiss, and however interesting they may be from a petrographic point of view, they furnish very little data for purposes of reliable correlation. The question of their origin, whether they are merely the metamorphosed facies of the Kolar hornblendic schists of igneous origin, or whether they constitute thermally altered representatives of an assemblage of a mixed series of sediments may be taken as still unsettled. The occurrence of manganiferous marbles in the series has suggested the alliance of the rocks with the gondite series of C.P. Manganiferous dolomites and limestones are found further west in the "middle division" of the Dharwar schists, and in some parts where the rocks are thermally metamorphosed, manganese silicates are also found developed in such limestones. The Sakarsanhalli limestone shreds with their manganiferous silicates may perhaps represent the remnants of a once continuous folded series of limestones, but reliable evidences are still lacking to prove this conclusively.

"For a successful solution of the problem of the correlation of our Archæan rocks I think it is necessary for each large area where they are typically exposed, to record how far it is clearly possible to classify the schists into different divisions on provable stratigraphic breaks, and when this has been done, to arrange for a joint investigation of such typical areas by a small body of experienced field geologists consisting of individuals representing the regions on which they have unquestionable knowledge."

Utilisation of Molasses.

A DISCUSSION on the utilisation of molasses took place at the meeting of the Chemical Section of the Indian Science Congress, on Monday, the 6th January 1936.

Dr. P. C. Guha, the President, in introducing the subject pointed out the great loss that molasses involve in sugar, amounting to something like 400,000 tons of sugar on the total production of molasses in the country and the consequent urgent need for utilising it profitably. He passed in review the various products for which molasses could be utilised, potable and industrial alcohol, fuel, acetic acid, acetone, butyl alcohol and glycerine, yeast, cattle feeds, manures and road binding material and briefly referred to the possibilities of each and to the work in progress in different parts of India in connection with them.

Dr. N. R. Dhar described how the addition to soil of carbon in the form of molasses leads to fixation of nitrogen. In the field as indicated by experiments at Allahabad and Shahjahanpur in the United Provinces and on the estates of Messrs. Parry & Co. in Madras, higher yields of sugarcane were obtained by the application of molasses at 90 to 270 maunds per acre. Rice has also favourably responded to manuring with molasses. To ensure the complete oxidation, it must be applied two or three months before planting sugarcane, the soil being frequently exposed by stirring and kept moist by irrigation. Molasses should not be applied to standing crops. Alkaline soils are benefited by the application of molasses and instances were quoted from the U. P. and Mysore in support.

Dr. Subrahmanyan stated that he found molasses toxic to crops in its first stages of decomposition but not so after a month. Under swamp conditions, lactic acid was the first product, followed by volatile fatty acids; considerable solution of ferrous iron and aluminium follows, which later on are precipitated or removed from solution. Fixation of atmospheric nitrogen does occur to some extent on direct application of molasses but it is wasteful of carbon. Fermentation with restricted air supply conserves the carbon and in conjunction with lime the application will lead to enhanced nitrogen fixation.

Dr. Chatterjee strongly advocated the manufacture of industrial alcohol for motor spirit and showed with the help of statistics that all the molasses produced by factories could be so utilized and urged the removal of the restriction on its manufacture. As there may be difficulties in introducing power alcohol throughout India, Dr. Chatterjee suggested that it should first be introduced in the U.P., which is the largest molasses producing Province. The cost of manufacture has been carefully calculated and falls within six annas per gallon. There are absolutely no difficulties in technical matters, regarding manufacture, distribution and wise supervision.*

Sir Bryce Burt emphasised the need for greater efficiency in factories and scientific work to reduce the sugar content of molasses and its quantity. As regards motor spirit, this could not be manufactured at anything like the 3 to 4 annas which was the price of petrol at the ports without duty and distribution charges. He would strongly urge the scope for using it for cattle feed and manure and of experiments towards that end.

Mr. A. K. Yegnanarayana Aiyer (President, Agricultural Section) said that in the direct consumption of sugar manufactured now universal in India, molasses are a product of some value. The expensive and elaborate arrangements made by the recently formed exporting company, *viz.*, transporting to the rail heads at the different places on the banks of the Ganges, shipping to Calcutta in special tank steamers down the river, extensive storage tanks at Calcutta and ocean shipment to England, all involving heavy expense go to prove the fact. If it should be worth the while of an exporting company to do all this, it should be much more so for utilisation in this country itself for similar purposes, as we could save all the expense of this elaborate transport. Industrial alcohol will certainly form the most profitable method of utilisation, but reasons of fiscal, administrative, and legislative difficulties rule this method out for the present. Utilisation as manure and as a cattle feed present promising outlets for the product, as India has an abundance of neither the one nor the other and both are also crying needs in the country. Manuring directly for a cane crop has not yielded satisfactory results, but if a sunn hemp crop is grown as the first crop on molasses manured land a very heavy yield of green manure is obtained which can be ploughed in for cane. This indirect method of cane manuring has been the one found promising in Mysore, as far as present experience goes. The method of application and the difficulties of transport to the fields will prove somewhat serious obstacles. The need for weathering emphasised by Dr. Dhar which should go on for nearly three or four months will likewise constitute another difficulty, as also the very large doses which he recommends and which in practice are really much too large. For paddy, a one ton dose on alkaline land has yielded good results, and if this should be confirmed by further trials it will provide a very large outlet for molasses, notwithstanding transport and other difficulties. A line of even greater promise is that of making a cattle feed like molascuite, using groundnut husks and haulms as the filler. Groundnut deserves to be and will be grown extensively as a rotation crop with cane and very large quantities of these will be available. It will mean the utilisation of the by-products of groundnut cultivation and the by-products of the sugar industry benefiting both the grower and the manufacturer. At the same time it will give a great stimulus to the improvement of the cattle industry and of dairying, by providing a valuable and largely available supply of cattle feed. (The manurial experiments referred to relate to only one season and should be regarded therefore as tentative and not conclusive by any means.)

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*An article by Dr. N. G. Chatterjee on Power Alcohol, appears elsewhere (pp. 662) in this number.

Traffic in Opium and Other Dangerous Drugs.*

TWO important pamphlets concerning the measures taken by the League of Nations in preventing illicit traffic have recently been published. One of these deals with the documents regarding the working of the system of import certificates and export authorisation, while the other is the report on the work of the Permanent Central Opium Board.

The Central Opium Board of the League of Nations is constituted to scrutinise the international trade in dangerous drugs as laid down in the Geneva Convention of 1925 and the Limitation Convention of 1931. The Board is empowered, where excessive stocks of any narcotic accumulate in any country, to take steps to overcome the danger.

In the year under review, the Board held four sessions. In the report the Board states that, while they have been able, by the application of the Articles of the Limitation Convention, to reduce greatly illicit traffic, they have been unable to end the traffic. The reason for this failure is the complicated mechanism of the administration of the powers of the Board. Forged certificates of import and export and also the different interpretations placed on the Articles of the Convention by the different governments have been mainly responsible for the continuance of illicit traffic.

From a study of the ways of the trade as stated by the Board, one comes to the conclusion that unless the international governments subscribing to the Convention wholeheartedly co-operate in ensuring the successful working of the Convention and take rigorous steps to restrict import and export of narcotics, the League of Nations Board will be ineffectual in its functions. After all the Board's authority is only moral and very little can be done unless a universal sense of morality prevails.

In the report the Board has discussed the difficulties of a strict application of the Articles of the 1931 Convention. A number of pages are devoted to statistics of the quantities of different narcotic drugs manufactured in the world. A few important facts that can be gathered from these tables are—

Morphine:—The quantity manufactured decreased in Germany, the United States and France by about 25 per cent, while it increased in Belgium, Poland, Hungary, Italy, Sweden and Czechoslovakia by about 86 per cent.

Heroin:—The quantity manufactured generally decreased everywhere except in Poland, Russia and Belgium. Nearly half the world's output of heroin comes from Japan.

Cocaine:—The decrease in the manufacture of this drug has not been so general. Five countries, namely, Poland, Czeckoslovakia, Russia, Belgium and the United States show an increase.

There is a movement in the manufacture of morphine and cocaine from old centres to new. No comparison could be made about figures for codeine and dionin as this is the first year of report on these drugs. It is found that the world's total output of heroin and cocaine is in excess of the requirements laid down in the Limitation Convention. More than a thousand kilograms in excess of the world's requirements have been manufactured during the year.

A glaring example of illicit traffic in opium is found in an instance where more than 5,000 kilograms of opium have been shipped from Turkey to Panama, Argentina, Ethiopia and Paraguay under forged certificates. The Board has drawn the attention of the Turkish Government to the matter and the latter has prosecuted some of the offenders and has undertaken to take the necessary action on others. This instance only emphasises the fact that countries dealing in these commodities should exercise great vigility in authorising import or export and that no restriction can be considered too rigorous to prevent fraud.

The Hague Convention of 1912 regulates the import and export of raw opium and aims at limiting the import and export of morphine, cocaine and their salts to persons granted by their respective governments authorisation or permits for the trade in narcotic drugs.

The Advisory Committee, at its first meeting in May 1921, took up the question of giving effect to the above-mentioned provisions of the Hague Convention. After a lengthy discussion, it adopted a system of import certificate, import authorisation, export authorisation, and export certificate, copies of which have to be transmitted to the importing authority, exporting authority, the import and export traders and the Customs of the two countries.

In the Geneva Convention of 1925 this system was improved upon by limiting the period within which a transaction should be completed and by adding cocoa leaf and Indian hemp to the list of raw materials and by increasing the number of substances that come under the purview of the Geneva Convention.

In 1928, the Committee drew up a Model Code of Administration which it has recommended to the several contracting governments to adopt.

In the present report, the Committee recommends the adoption of a uniformity of forms by the various authorities concerned in the trade as discrepancy in this has led to forgeries. It recommends also the use of either English or French as language in these transactions to avoid administrative delays. The Committee emphasises very strict control and scrutiny of the import and export trade. A few recommendations regarding the number of copies, the possibility of using special paper for these certificates and the disposal of import and export certificates are made to ensure a vigilant control over the trade.

There is no doubt that, if all the governments involved in the trade adopt these recommendations in their administration, it will be possible to greatly reduce the illicit traffic in dangerous drugs that is so prevalent in the world and also provide the Central Opium Board with better means of gauging the situation.

K. S. V.

* League of Nations Publications Series, 1935. Vol. **11**, No. 8. Permanent Central Opium Board: Report to the Council on the work of the Central Board during its 22nd, 23rd, 24th and 25th meetings. Vol. **11**, No. 11. Advisory Committee on Traffic in opium and other dangerous drugs: studies and documents regarding the working of the system of import certificates and export authorisation.

Science Notes.

Evidence tending to show that man existed in North America before the Ice Age is put forward by Prof. Paul Macclintock of the Department of Geology of Princeton University as a result of the discovery of human implements in the White River region of South Dakota and Nebraska and deposited there before the time of the great glacier. Prof. Macclintock assisted by Justus S. Templeton, discovered last summer varied sediments in the bed of an extinct lake of the White River which was dammed by the last advance of the ice sheet. Knowing that these sediments must be contemporaneous with the ice sheet, they figured that man-made artifacts found in or below the lake sediments would prove that man was there before the ice. Accordingly, aided by geologists from the Nebraska State Museum, they dug below the sediments and found not only many artifacts but scores of hearthpits containing charcoal, burned stones, and burned bones of extinct animals (*Science*, Jan. 31, 1936, Supp. 7). The pits, which are two or three feet wide and one or two feet deep, seem to have been used to preserve the fire from day to day. While no skeletons of the ancient people have yet been found, hopes are held for excavations in coming seasons.

* * *

M. Pavlov.—In the death of Pavlov at the age of 86, the world has lost an eminent physiologist of international reputation. He was a Nobel Prizeman, having been elected to that distinction in 1904, in recognition of his researches on the functions of the digestive glands. Professor Pavlov was the recipient of numerous honours—he was Foreign Member of the Royal Society (1907), elected Member of the Russian Academy of Sciences (1907), and Hon. Fellow of the Royal College of Physicians (1928). He was awarded the Copely Medal in 1918. As Director of Physiological Laboratories in the Russian Academy of Medicine and the Institute of Experimental Medicine, he attained world-wide fame and carried out extensive investigations on the problems of digestion, of cerebral activity and the theory of reflexes.

* * *

Improved Varieties of Cotton in Sind and Their Cultivation.—The recommendations of a practical character made in the leaflet issued by the Department of Agriculture in Sind are the outcome of considerable botanical research work carried out by the Department during the past ten years. The Department's investigations have borne fruit in the evolution of several improved varieties of cotton which have been thoroughly tested in the main cotton growing districts both on Government Farms and on zamindari lands and have been found to be most suitable for general cultivation in the different cotton growing tracts of the Barrage areas.

The three main classes of cotton found to be successful in Sind are:—(1) Sind American, (2) Imported Egyptian and Sea Island, and (3) Sind Deshi, and among each of these classes the Department has by botanical selection evolved improved strains specially suited to Sind conditions.

The leaflet describes in detail the characteristics of these new strains and follows it up with a note on the preparation and lay-out of the land for cotton cultivation, the suitable seasons for sowing, the advantages for interculturing and the time when picking should take place.

Of the 5 varieties described the Department specially recommends the growing of "Sind Sudhar" (Sind American 289 F.) which is characterised as the "Bread and Butter" cotton of the advanced cotton growers in the Barrage areas. Sind Sudhar is stated to be a high yielding variety and on account of its hardiness and ability to withstand adverse climatic conditions, jassid attacks, "red leaf" and on account of its freedom from bad opening of bolls, it has surpassed most of the American varieties of cotton so far cultivated in Sind in point of yield and general utility. The variety is suitable for spinning up to 40's standard warp counts; has a ginning outturn of 30% and was valued in 1935 at Rs. 80 on Broach.

Two other important varieties evolved from Imported Egyptian and Sea Island cotton which are still in the large-scale experimental stage are: (1) Sind Sea Island cotton and (2) Sind Boll III cotton, both of which are of high quality, very long stapled cottons, possessing silky fibre and spinning up to 80's counts. As a result they command a high price in the market having been sold during 1934–35 at a premium of Rs. 150–180 on Broach. Of recent years considerable interest has been taken by Indian mills in Bombay and Ahmedabad in these high quality varieties.

Pure seed for all these new strains are available at the office of the Cotton Supervisor, Left Bank, Mirpurkhas and the Cotton Supervisor, Right Bank, Dadu, or the nearest agricultural officer or Government Farm.

* * *

Air Seasoning of Soft Wood Railway Sleepers.—Various recommendations based on experiments and experience for improving the soft wood sleeper situation in the Punjab have been incorporated in a report by Dr. S. N. Kapur assisted by Azizul Rahman recently published by the Government of India (*Indian Forest Records.* (New Series), *Utilization*, 1, 2). The increasing rejections in the case of coniferous sleepers have been a cause of anxiety to all forest authorities in the Punjab and Kashmir. These rejections are due to end cracks which the sleepers develop during the period elapsing between the exploitation in the forest and their arrival at the final destination on the line. The end-cracking is caused by too rapid drying at the ends and means should be adopted to retard the rate of end-drying; painting the ends of freshly sawn scatterings with coal-tar has been found to be quite effective not only in saving the ends but also in reducing damage by other seasoning defects such as surface cracking, opening out of shakes, split-knots, etc. On account of the milder climate of the forests, as compared with that of the plains, sleepers season much better there, and from a practical point of view the seasoning at the launching depots seems to offer the best solution of the problem. Such sleepers should be launched so as to arrive at the depots early in the cold weather, and stacked properly with the least possible delay, after giving a coat of coal-tar at the ends. The stacks themselves

should be well protected to slow down the rate of drying, and the depots should have provision of shade trees and shelter belts. The Report covers 75 pages and is provided with 2 plates, and 18 tabular statements of experimental results.

* * *

Plywood and Insect Pests.—Plywood is made in India from hollong (*Dipterocarpus macrocarpus*) and hollock (*Terminalia myriocarpa*), by two factories in Upper Assam which supply plywood chests to the tea gardens of that province. During the past two or three years the reputation of tea chests made of these timbers has suffered somewhat owing to liability to damage by borers. Recent investigations by the Forest Entomologist have discovered remedies by which Indian plywood can be rendered immune to borer attack. The indigenous product is in no way inferior to imported plywood in this respect.—(*Indian Forester*, 1936, **62**, 162.)

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Study of the Blood Groups in the Christians and Hindus of Goa.—Dr. Pachico de Figueredo has made a study of the hæmetic groups among the Christian and Hindu natives of Goa, for which purpose he examined 509 persons, of whom 309 were Christians. The results show that the percentages of the different groups—Christians and Hindus—of Goa are very much similar, preponderating the O group, and being followed according to the frequency by the groups BA and AB. A similar observation has been made in the case of the Hindus of Ceylon. The Hirzfeld index is 0·71 in the case of the Hindus of Ceylon while it is much higher in the case of the Christians (0·83) and Hindus (0·84) of Goa. Prof. Germano Correia found an index of 0·84 for the Mahrattas.

* * *

Asiatic Society of Bengal.—At the ordinary meeting of the Society held on the 2nd March, Dr. Baini Prashad exhibited a *Rufous-necked Hornbill*, a specimen of which he obtained during his recent tour in the Barail range of Manipur. "In Vol. XVIII, Part I, of *Asiatick Researches* for 1829, B. H. Hodgson, the father of Vertebrate Zoology in India, described in detail the Rufous-necked Hornbill under the name *Buceros nepalensis* and published two coloured plates of this beautiful bird. Later, Blyth, the well-known Curator of the Society's museum, in 1847, exhibited mounted specimens of males and females of this species. The author during a recent tour in the Barail range of Manipur obtained a specimen of a full-grown male of this species at Nungba. This specimen shows certain differences in the oblique black grooved bands extending across the basal portion of the beak." The specimen was exhibited together with some other specimens from the collections of the Zoological Survey of India. The species now known as *Aceros nepalensis* has a wide distribution in Nepal, Bengal, Assam, Manipur, Lushai Hills, mountains of Burma, Karenni up to Mount Muleyit, Tenasserim and Siam. It has also been recorded from Siam and Tonkin.

Other exhibits shown and commented upon were: (1) Kabui Naga Cloths by Dr. Baini Prashad, (2) A shorter version of the *Kaulavali-nirnaya* by Mr. Chintaharan Chakravarti, and (3) A recent detailed map of Abyssinia by Mr. Johan van Manen. A paper entitled "Notes on a Fourth Tour in the District of Dinajpur" was read by Sarasi Kumar Saraswati.

Mr. Richard Arnold Shyring Thomas, Dr. Manomohan Chatterjee, and Mrs. Tuhinika Chatterjee, were balloted for as ordinary members at the same meeting.

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The Prince of Wales Museum of Western India.—The latest report published by the Trustees of the Museum brings out clearly the scope and nature of the important work that is being carried out by the different sections of the Museum. During the year 1934–35, Nawab Sir Akbar Hyder Jung, generously presented his interesting collection of copies of the Ajanta frescoes to the Museum. The iconographical section was enriched by the addition of no less than 60 icons of Vaishnavite, Saivaite and Sakta schools. The construction of the new wing of the Museum was taken in hand during the year with a view to providing relief to the Art Section which at present is overcrowded. This extension will enable the fine bequest of the late Sir Dorab Tata's exhibits to be suitably displayed to the public. The Natural History Section carried out a scientific survey of the Eastern Ghats. The work dealing with the bird collections obtained by the Survey and published in the *Journal of the Bombay Natural History Society*, constitutes one of the most important contributions to Indian ornithology made in recent years. Mr. Salim A. Ali assisted by Mr. E. Henricks, carried out a bird survey of the Eastern portion of the Hyderabad State and the Travancore and Cochin States. A bird survey was also carried out in the Jodhpur State by Mr. V. S. La-Personne assisted by Mr. E. Henricks. Mr. A. S. Venay, undertook an extensive expedition to the Upper Reaches of Chindwin river in Northern Burma, with a view to collecting Mammals, Birds, Reptiles, Amphibians and Fish. A large collection was made which will be worked out in the American Museum of Natural History, New York. The various surveys have considerably added to the Museum collections in the Mammal Gallery, Bird Gallery, Reptile and Fish Gallery, and the Insect and Invertebrate Gallery. Among the notable acquisitions, may be mentioned, the bones of a large Baleen whale which was washed up at Colaba during the month of May 1934 (see *Curr. Sci.*, 1934, **3**, 3), a specimen of the long-tailed Duck (*Clangula hyemalis*) from Chaman, Baluchistan, presented by Mr. A. E. L. Dredge, which is the first recorded occurrence of this species within Indian limits, and a collection of several hundred insects collected during the monsoon of the year (1934–35), contributed by Mr. C. MacCann from Salsette. This collection is of particular interest as it shows the progress of insect life during the four months of the rains.

* * *

Indian Chemical Society.—At the twelfth annual general meeting of the Society held on Monday, 6th January 1936, at Indore, it was resolved to dispose off 50 sets of the back issues of the *Journal of the Indian Chemical Society* at the following concession rates:

Vols. I and II	..	at Rs. 6 per Volume
Vols. III to X	..	at Rs. 8 ,,
Complete set (Vols. I to X) at Rs. 50		

The freight charges will have to be borne by the purchaser. The price of the Sir P. C. Ray

Commemoration volume is reduced and Fellows can obtain it at Rs. 1–8–0 per volume.

* * *

Mysore Serum Institute.—The work carried out by the Superintendent of the Institute and his staff during the year 1934–35, is set forth in the annual report which we have recently received. The chief item of work was to prepare, as usual, large quantities of several important biological products such as Anti-Rinderpest Serum, Rinderpest Bull and Goat Virus, Anti-Hæmorrhagic Septicæmia Serum, Hæmorrhagic Septicæmia Vaccine, Anti-Black Quarter Serum, Black Quarter Filtrate and Bacterin, Anti-Anthrax Serum, Sheep-pox Vaccine, etc., required for controlling most of the contagious diseases of livestock, as also to supply the same on indents from the Veterinary Officers of the Mysore Civil Veterinary Department and from the several other customers outside the State. The other important activities of the Institute were to conduct experiments and to carry on researches, with a view to improve the technique of preparation of the biological products, so as to increase their efficacy, and also to prepare some more new products in the light of the accumulated experience gained in the Institute and with reference to the latest literature.

During the year there was a considerable decrease in the demand for the main products, *viz.*, Rinderpest Serum and Bull Virus, owing to a further appreciable decline in the incidence of Rinderpest among the cattle in the State. Besides as the advantage of using "Goat Virus alone" as a single vaccine in preference to "Serum Simultaneous method" was confirmed by field experiments, even on the scenes of actual outbreaks, the Mysore Civil Veterinary Department adopted chiefly the "Goat Virus alone" inoculations with great success, to combat even the few outbreaks of Rinderpest that occurred among the cattle in some parts of the State, thus dispensing with the use of Anti-Rinderpest Serum and Bull Virus. As a result of this, there was practically no demand for these two products from within the State, and hence, their output had to be curtailed proportionately.

As regards the production and supply of other biologicals, the Black Quarter Bacterin, which was introduced only last year for field use on an experimental scale, having been found to be decidedly superior to Black Quarter Filtrate in its antigenic properties, the former alone was used in preference to the latter in almost all cases within the State; and hence the production of Black Quarter Filtrate was reduced by about 50 per cent. But at the same time, the Black Quarter Bacterin which was in greater demand, was prepared in much larger quantities nearly 16 times larger than that in the previous year.

A noteworthy feature in the work of the Institute during the year, was the preparation of three new products on an experimental scale, *viz.*, Anti-Fowl Cholera Serum, Anti-Anthrax Serum (Equine) and Anthrax Live Spore Vaccine. The first one, *viz.*, Fowl Cholera Serum, was already issued to some of the Veterinary Inspectors of the State for being tried in the field, and the results reported thereon are encouraging. The Equine Anthrax Serum could not however be tried in the field as there was no demand for the same from anywhere. The Anthrax Spore Vaccine is still under test and it is expected to be ready soon for issue for field use.

Facilities for the investigation of Johne's disease among cattle in the State for which the Imperial Council of Agricultural Research has given a grant, were provided by the Institute.

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The Faraday Society.—A general discussion on the "Disperse Systems in Gases, Dust, Smoke and Fog" will be held in the Chemistry Lecture theatre of the University of Leeds, from Monday to Wednesday 20th–22nd, April 1936. The subject will be discussed under the following heads :—

Part I. "*General*" : with a general introduction by Professor R. Whytlaw-Gray.

Part II. "*Special*" : with a general introduction by Dr. R. Lessing.

Prof. E. N. Da C. Andrade (London), Dr. O. Brandt and Dr. E. Hiedemann (Koln), Dr. J. H. Costa (London), Dr. G. B. Courtier (London), Dr. P. Drinker (Harvard), Prof. J. Firket (Liege), Dr. N. Fuchs (Moscow), Mr. C. F. Goodeve and Mr. A. F. Dooley (London), Mr. H. L. Green (Porton), Dr. W. R. Harper (Bristol), Mr. A. S. C. Hill (Porton), Prof. G. Jander (Greifswald), Prof. H. Kohler (Upsala), Prof. V. Kohlschutter (Bern), Dr. J. J. Nolan (Dublin), Prof. J. C. Philip (London), Mr. H. H. Watson (Porton) and Dr. F. J. W. Whipple (London) and others will contribute papers.

An exhibition of apparatus and instruments relevant to the subject under discussion will be arranged. The exhibition will be open throughout the meeting and demonstration will be given between 2 P.M. and 4 P.M. on Tuesday, 21st April.

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The Council of the Institution of Electrical Engineers have made the fourteenth award of the Faraday Medal to Sir William H. Bragg. This award is made either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, residence or membership of the Institution.

* * *

It is announced in *Nature* that the Council of the Royal Asiatic Society have conferred honorary membership upon Prof. Georges Coedes, of the Ecole Francaise D'Extreme Orient, Hanoi, Indo-China, in recognition of his eminent services to the history, epigraphy and geography of the Malay Peninsula and the Far East; and upon Prof. H. E. Winlock, Director of the Metropolitan Museum, for his distinguished services in the cause of Egyptology.

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Dr. C. Stuart Gager, Director of the Brooklyn Botanic Garden, Brooklyn, New York, has been elected President of the Botanic Society of America. The Brooklyn Botanic Garden ceased to be the publishers of the *American Journal of Botany*, from January 1936. The Botanical Society of America will continue the Journal independently.

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Dr. S. N. Chakravarthy, Professor of Chemistry, Annamalai University (says an A. P. I. message), has been appointed Chemical Examiner to the Government of the United Provinces. Dr. Chakravarthy is a Fellow of the National Insti-

tute of Sciences and also a Fellow of the Indian Academy of Sciences. He is a member of the Executive Council of the Indian Chemical Society.

* * *

Vanadium and Titanium Smelting.—It is reported that Soviet Russia is now independent of foreign imports of Vanadium and Titanium, as metallurgists have succeeded in producing them (*Chemical Age*, Feb. 1, 1936, **8**). Ferro-vanadium is an alloy that imparts elasticity to steel and increases its tensile strength; titanium gives hardness to steel, and also a brilliant lustre to silver. Metallurgical difficulties were solved by the discovery that titanium ore, which contains ferro-vanadium and titanium could be smelted in the blast furnace. For a number of years Soviet works have been experimenting with various methods of smelting the ore, and in 1929 Prof. Pavlov tried the blast furnace method without satisfactory results. Subsequently Prof. Shadlun found a way to separate the titanium from the ferrous component of the ore before smelting, and the Ural Institute of Rare Metals carried these experiments a stage further and improved upon them.

* * *

Zirconium Oxide.—Zirconium oxide would appear to be a very promising material for the manufacturing of laboratory apparatus. Its melting point is about 2,700° C., whilst its chemical stability to acids and alkalies is very great. Chemically pure zirconium dioxide, however, cannot be worked up ceramically, since it undergoes an allotropical change at about 1,000° C. This change is principally an alteration in specific volume, and a crucible or other container which has been moulded at ordinary temperature loses its shape. It has been found, however, that a slight addition of other oxides particularly magnesium oxide or beryllium oxide, prevents this conversion at least up to 2,500° C. This modified zirconium ware is, however, not quite suitable for work in vacuum, since it is in general not completely tight to gases. It has been found possible to obviate this drawback, however, but only at the cost of the temperature resistance of the material. Zirconium vessels, in addition, are comparatively sensitive to temperature changes since the oxide has a relatively high rate of expansion and a relatively low heat conductivity.—(*The Chem. Trade Jour. and Chem. Eng.*, Feb. 7, 1936.)

* * *

Cheap Steam Generation: Value of Low Grade Fuels.—Mr. David Brownlie, 46, Grange Road, Ealing, London, W. 5, writes:—The only scientific method of operating steam boilers is to adapt the equipment so that any quality of fuel can be burnt, from the highest to the lowest, including vegetable refuse material, without regard to the ash and moisture content and the physical condition.

Fuel is then used according to the price paid per available heat unit so as to give the lowest cost for evaporating in the boilers, say 10,000 lbs. of water. That is, a cheaper fuel, such as small coal is often of much better value than high-grade expensive qualities, under conditions of course that in each case a reasonably good thermal efficiency can be obtained.

In this connection of great value is the "Turbine" forced draught furnace, operated with either steam jets or forced draught fans with trunking, and with either hand firing or the use of mechanical sprinkler stoker gear. What can be accomplished in this field is well illustrated by the boiler plant of a well-known London soap works with great fluctuations in the steam demand which makes efficient operation more difficult.

This has three "Lancashire" boilers, and originally two of these were equipped with the "Turbine" furnace, one boiler being operated by oil fuel. Eventually, however, this latter method was abandoned, and a forced draught furnace fitted on the third boiler, coal being first used followed afterwards by coke.

Incidentally it may be stated that on the oil-fired boiler alone the substitution of coal for oil resulted in a saving of £ 450 per annum, and in most countries, coal whether anthracite, semi-anthracite, bituminous, or sub-bituminous, will generate steam much cheaper than oil. In London, for example the average price of oil at say 19,000 British Thermal Units of Heat per lb. is 70/ to 75/ per ton, whereas high-grade coal of 12,000 to 14,000 B. Th. U. is 25/ to 30/ per ton, representing less than half the price per available heat unit. It should also be pointed out that under proper conditions coal firing is just as thermally efficient as oil.

This particular soap works plant in London afterwards went on to burn Scottish anthracite, and following on this they used a blend of the anthracite with Kent coal, which is highly volatile. The point is that anthracite, ordinary bituminous coal, a special highly bituminous coal, and town's gas coke have been used indiscriminately at high efficiency, due to the forced draught furnaces, allowing a complete choice of fuels according to the variation in price and quality, that is the cost per available heat unit. In addition all kinds of low-grade woody and vegetable material can be used without difficulty.

The design of the furnace, a production of the Turbine Furnace Co. Ltd., (238, Grays Inn Road, W. C. 1.) is of course already well known, consisting in the use of a series of longitudinal trough firebars each equipped with a large number of transverse elements or small bars distributing the forced draught blast uniformly throughout the area, this being given, as already indicated, either by means of steam jets or fans. In the latter case the power is extremely small, less than 2 H.P. for a standard 30′ 0″ × 8′ 0″ "Lancashire" boiler, while steam jets take about 2–2½% of the evaporation of the boilers, that is, approximately the same as induced draught. Which is the best method to use, however, depends entirely upon the local conditions, including the nature of the fuel, the size and type of the boilers, the average rate and also the fluctuations in the evaporation.

* * *

The Chemical Engineering Congress.—The Technical Proceedings of the Chemical Engineering Congress of the World Power Conference, to be held in London from June 22 to July 27, next, are grouped into the following main sections for discussions of papers, etc. (*a*) Ferrous metals in chemical plant construction; (*b*) Refractories, rubber plastics and other materials in chemical plant construction; (*c*) Separation; (*d*) Size reduction, grading and mixing, electrolysis and

electrical applications; (*e*) Destructive distillation; (*f*) Treatment and disposal of effluents and waste materials, lubrication; (*g*) High-pressure reactions and high vacua; (*h*) Heat exchange; (*j*) Education and Training; (*k*) Statistics, administration, safety and welfare; (*l*) Trend of development; and (*m*) General Aspects. Copies of provisional time table, etc., can be obtained from the International Secretary, Chemical Engineering Congress, 36, Kingsway, London, W.C. 2.

* * *

The Sixth International Congress of Physical Medicine will be held in London, on May 12–16 under the presidency of Lord Horder. Further information can be had from the Hon. Secretary, Dr. Albert Eidinow, 4, Upper Wimpoll Street, London, W. 1.

* * *

The Seventh International Congress of Refrigeration will be held at the Hague and Amsterdam on June 16–17. The Congress will be divided into the following sections: (1) Scientific (physics, chemistry, thermodynamics, units, biology and medicine); (2) Refrigerating machines and materials (air-conditioning, insulating materials, refrigerating plants and testing methods); (3) General applications of Refrigeration (food and perishable products, agricultural industries, ice industries, chemical and rare gas industries (low temperature); (4) Refrigerated transport, etc. (land and water transport, legislation, education and propaganda, general economics and statistics).

Further information can be obtained from the Organisation Office, 107 Stolbergloan, the Hague.

* * *

The 14th Congress of Chambers of Commerce of the British Empire will be held in Wellington, New Zealand, at the beginning of October next. It is understood that the Governor-General of New Zealand has provisionally accepted to open the Conference on October 2, 1936.

* * *

Spectrometric Equipment.—We have recently received from Messrs. Bausch & Lomb Optical Co., Rochester, New York, U. S. A., their catalogue D-221 (Jan. 1936) giving an eminently readable account of the various types of spectroscopes. The contents comprise Basic Theory and Designs, Direct Vision Spectroscopes, Burner Spectroscopes, Laboratory Wave-length Spectrometer, Quartz ultra-violet monochromator, large spectrometer and equipment for spectrophotometers for (*a*) transmission measurements through fixed thicknesses, (*b*) transmission measurements through fixed or variable thicknesses, (*c*) reflection measurements, and (*d*) transmission measurements through fixed thicknesses and reflection measurements. A price list is also provided. Details regarding the equipment can be had either from Bausch & Lomb Optical Co., U. S. A., or from their Indian representatives, Messrs. Martin & Harris, Ltd., Prinsep Street, Calcutta.

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Announcements.

UNIVERSITY OF MADRAS.

The Sir William Wedderburn Prize, 1936 :—

The prize, which will consist of books of the value of Rs. 45, will be awarded to the student, who, having qualified in Chemistry for the Degree of B.A. (Honours), or B.Sc. (Honours), or M.A., or M.Sc., not more than two years previously, has shown aptitude for research.

A thesis on any research work conducted by the student should be submitted with the application.

Competitors should submit their theses so as to be received by the Registrar not later than the 30th June, 1936.

Further particulars governing the award of the above prize will be found in volume II of the *University Calendar for* 1934–35.

* * *

Second International Congress for Microbiology, London, 25th July–1st August, 1936.—The Congress will be officially opened on Saturday evening the 25th July, 1936. This will be followed by official receptions by His Majesty's Government, by the Royal Society and other societies. Excursions and visits to important institutes and laboratories have been arranged.

Prospective members are requested to communicate, without delay, either with Dr. A. C. Ukil, Secretary, Indian Committee of the International Society for Microbiology, All-India Institute of Hygiene and Public Health, 21, Chittaranjan Avenue, Calcutta, or directly with Dr. R. St. John-Brooks, Honorary General Secretary, Second International Congress for Microbiology, Lister Institute, Chelsea Bridge Road, London, S.W. 1, England, for a copy of the Registration Form and the Programme and to forward the membership fee of £ 1 sterling to Dr. J. T. Duncan, Treasurer, Second International Congress for Microbiology, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C. 1. Members should also intimate the Honorary General Secretary in London whether they would be accompanied by ladies.

The headquarters of the Congress will be located at the University College, Gower Street, London, W.C. 1, where the scientific meetings will also be held.

In accordance with the Statutes of the Society communications may be made to the Congress in English, French or German. The Honorary General Secretary will be glad to hear from any prospective member who desires to take part in the general discussion on any of the prescribed subjects. All openers of discussions and subsequent contributors must forward to the Honorary General Secretary, Dr. R. St. John-Brookes, before 1st April 1936, abstracts of their statements for incorporation in a special brochure available at the opening of the Congress. These abstracts are strictly limited to 600 words in case of openers and to 300 words in case of subsequent contributors.

PROVISIONAL PROGRAMME.

Presidents of Honour:

Past President Professor Jules Bordet (Brussels), Sir John McFadyean (London), Sir Robert Muir (Glasgow), Professor Geo. H. F. Nuttall (Cambridge).

President:

Professor J. C. G. Ledingham, Lister Institute, London, S.W.1.

Presidents of Sections:

Section.	President.
1. General Biology of Micro-organisms.	Prof. E. Gotschlich (Heidelberg).
2. Viruses and Virus diseases in plants and animals.	Prof. R. Doerr (Basel).
3. Bacteria and fungi in relation to disease in man, animals and plants.	Dr. E. J. Butler (London), and Prof. H. Zinnser (Boston).
4. Economic Bacteriology (Soil, Dairying and Industrial).	Prof. R. E. Buchanan (Iowa).
5. Medical, Veterinary and Agricultural Zoology and Parasitology.	Prof. E. Brumpt (Paris).
6. Serology and Immunochemistry.	Prof. K. Landsteiner (New York).
7. Microbiological Chemistry.	Prof. A. Harden (London).
8. Specific immunisation in the control of human and animal diseases.	Prof. W. H. Park (New York).

* * *

We acknowledge with thanks the receipt of the following :—

"Bulletin of the U.P. Academy of Sciences," Vol. V, Part II, December 1935.

"Nagpur Agricultural College Magazine," Vol. X, No. 3, February 1936.

"The Agricultural Gazette of New South Wales," Part 2, February 1936.

"The Journal of Agricultural Research," Vol. 51, Nos. 6–9.

"Indian Journal of Agricultural Science," Vol. VI, Part I, February 1936.

"Journal of Agriculture and Livestock in India," Vol. VI, Part I, Jan. 1936.

"The Philippine Agriculturist," Vol. XXIV, No. 9, February 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4340–4343.

"Biochemical Journal," Vol. 29, No. 12, December 1935.

"Chemical Age," Vol. XXXIV, Nos. 865–868.

"Journal of Chemical Physics," Vol. 4, No. 2, February 1936.

"Journal of the Indian Chemical Society," Vol. 12, No. 12, December 1935; Vol. 13, No. 1, January 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 2.

"Russian Journal of General Chemistry," Vol. V, No. 10.

"Journal de Chimie Physique," Vol. 33, No. 1.

"Experiment Station Record," Vol. 74, No. 1, January 1936.

"Transactions of the Faraday Society," Vol. XXXII, No. 2. February 1936.

"Bulletin of the Fisheries and Marine Biological Survey (Department of Commerce and Industries, Union of South Africa)," Bulletin No. 2.

"Indian Forester," Vol. LXII, Nos. 2–3; Index to Vol. LXI.

"Forschungen und Fortschritte," Vol. 12, Nos. 4–6.

"Indian Trade Journal," Vol. CXX, Nos. 1546–1550.

"The Calcutta Medical Journal," Vol. 30, Nos. 7–8.

"Medico-Surgical Suggestions," Vol. 5, No. 1, January 1936.

"Terrestrial Magnetism and Atmospheric Electricity," **40**, Sept. 1935.

"The Madras Presidency College Botany Magazine," Vol. III, No. 1, February 1936.

"Monthly Bulletin of Agricultural Science and Practice," (International Institute of Agriculture, Rome), *Year* 27, No. 1.

"The Royal Institute of Science Magazine," Bombay, February 1936.

"Journal of the American Museum of Natural History," Vol. 37, No. 1, Jan. 1936.

"Nature," Vol. 137, Nos. 3456–3459.

"Journal of Nutrition," Vol. 11, No. 1.

"Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science," Vol. X, Part I.

"Canadian Journal of Research," Vol. 13, No. 6, Sections A, B, C and D.

"Journal of Research," (National Bureau of Standards), Vol. 15, No. 4, Oct. 1935.

"Science and Culture," Vol. I, No. 9, February 1936.

CATALOGUES.

Spring and Summer Books (The Cambridge University Press), 1936.

Monthly List of Books on Natural History and Science (Wheldon and Wesley, Ltd.)

Academies and Societies.

Indian Academy of Sciences.

February 1936. SECTION A.—MAX BORN: *Unitary Theory of Field and Matter. II. Classical Treatment. Charged Particle with Electric and Magnetic Moment.*—If the classical treatment of the unitary theory has any meaning at all, it leads to the conclusion that point singularities are not the correct representation of particles. P. K. RAMAN: *The Measurement of the Transmission of Heat by Convection from Insolated Ground to the Atmosphere.*—With the apparatus described, it is shown that a simple formula can be used for estimating the rate at which heat is transferred to the atmosphere from heated grounds in terms of the surface temperature of the ground, and the meteorologically measured quantities, temperature of air and wind velocity at 4 ft. M. U. PARMAR, S. M. MEHTA AND MATA PRASAD: *Studies in Thorium Phosphate Gels.* C. V. RAMAN AND N. S. NAGENDRA NATH: *The Diffraction of Light by High Frequency Sound Waves: Part IV.—Generalised Theory.* R. S. KRISHNAN: *Molecular Clustering in Liquid Fatty Acids.*—Of the four acids, formic, acetic, propionic and n-butyric, the first two alone show a value of less than 1 for the depolarisation factor ρ_h with the incident light horizontally polarised. This indicates presence of large molecular clusters in them. S. BHAGAVANTAM AND A. VEERABHADRA RAO: *Deformation Frequencies in the Raman Spectra of Linear Molecules: Acetylene.*—Two new bands at $\Delta\nu$ 589 and 646 have been recorded in the Raman spectrum of acetylene gas by giving a long exposure, and their origin is discussed. Dr. N. R. TAWDE: *Intensities in the Bands of the Violet Cyanogen System.*—The vibrational intensities in ${}^2\Sigma \rightarrow {}^2\Sigma$ system of CN have been utilised to explain some aspects of Condon's theory. P. K. SESHAN: *The Absorption Spectra of Some Aromatic Compounds. Part I.—Hydrocarbons.*—Several aromatic hydrocarbons have been studied for their absorption spectra in the vapour state over the spectral range 7000 Å to 2200 Å. P. K. SESHAN: *The Absorption Spectra of Some Aromatic Compounds. Part II.—Quinones and Hydroquinones.*—Many of the spectra show a vibrational structure, and some of them also a rotational fine structure. B. NAGESHA RAO: *Diamagnetic Susceptibility of Sulphuric Acid-Water Mixture.* —There is no definite break anywhere in the concentration susceptibility curve, and thus the magnetic measurements do not support the theory which assumes the presence of definite hydrates in solution.

February 1936. SECTION B.—COL. I. FROILANO DE MELLO: *An Explanation to the Occurrence of Sporadic Cases of Urinary Schistosomiasis in India.*—A definite case of human urinary Bilharziosis was registered in October 1934, the infection being probably conveyed by some local mollusc. It is reasonable to postulate that the infection occurred only *eventually, accidentally* in a mollusc showing some affinities to these miracidia. LT.-COL. PROF. ALBERTO CARLOS GERMANO DA SILVA CORREIA: *The Blood Groups in Portuguese India.*—This constitutes the first contribution on the blood groups in Portuguese India. The studies concern the Marathas. COL. I. FROILANO DE MELLO AND MISS CIRIACA VALLES: *On a Trypanosome Found in the Blood of the Indian Fresh Water Fish* Clarias batrachus *Linn.*—Fishes of the genus *Clarias* are parasitised by trypanosomes, which on morphological grounds are considered to be varieties of a single species. M. B. MIRZA: Subulura hindi *n. sp. A New Nematode Parasite of* Sciurus palmarum.—The male and female worms have been described. BENI CHARAN MAHENDRA: *Contributions to the Osteology of the Ophidia. I.—The Endoskeleton of the so-called "Blind-Snake",* Typhlops braminus *Daud.*—The osteological features of four alizarin-stained specimens of *Typhlops braminus* have been described. T. R. BHASKARAN AND V. SUBRAHMANYAN: *Studies on the Mechanism of Biological Nitrogen Fixation. Part I.—Economy of Carbon during Fixation of Nitrogen by the Mixed Flora of the Soil.*—The water soluble residue obtained during the decomposition of glucose by the mixed flora of the soil is largely utilised for the fixation of nitrogen. T. R. BHASKARAN: *Studies on the Mechanism of Biological Nitrogen Fixation. Part II.—Rôle of Lime in the Fixation of Nitrogen by the Mixed Flora of the Soil.*—The presence of calcium carbonate in the medium serves to maintain the medium at the neutral reaction, when the fixation proceeds unimpaired. L. RAMA RAO, S. R. NARAYANA RAO AND K. SRIPADA RAO: *On the Age of the Deccan Traps near Rajahmundry.*—The examination of the fossiliferous sediments associated with the Deccan Traps near Rajahmundry confirms other palæontological evidence in support of the eocene age of the Deccan Trap. C. BHASHYAKARLA RAO: *The Myxophyceæ of the United Provinces, India. II.*—The communication deals with some Myxophyceæ (hitherto unrecorded with the exception of *Stichosiphon indica* Rao) from Benares.

Indian Mathematical Society:

June 1935. "A NOTE ON THE VALUES OF AN ANALYTIC FUNCTION NEAR AN ESSENTIAL SINGULARITY." V. *Ganapathy Iyer.* Let $f(z)$ be an integral function. Let the z-plane be divided into rings Γ_n, $n = 1, 2, ..$ by circles with centre at the origin and radii $\frac{3}{4}.\ 2^{n-1}$ and $\frac{3}{4}.\ 2^n$. Let $f_n\ (z) = f\ (2^n\ z), n = 0,\ 1,\ 2,..$ With this notation, P. Montel has stated without proof, in *Collection de Monographies de E. Borel*, pp. 80–81 the following:

(1) there cannot exist two different numbers a and b such that the numbers of zeros of $f\ (z)-a$ and $f\ (z)-b$ in Γ_n have a finite upper bound as n tends to infinity.

(2) the family $\{f_n(z)\}$ cannot be quasi-normal in Γ_1.

Ganapathy Iyer shows that both these statements of Montel are incorrect, by considering the example $\phi(z) = \prod_{n=1}^{\infty}\left(1 - \frac{z}{2^n}\right)$. He proves that for this function, for an infinity of values of a,

$\phi(z)-a$ has just one zero in Γ_n, and that the family $\phi_n(z)$ is quasi-normal in Γ_1.

THE ASYMPTOTIC CURVES OF THE CUBIC AND QUARTIC SCROLLS. *C. N. Srinivasiengar.* Wilczyuski and Snyder have studied the properties of the asymptotic curves of the two types of cubic scrolls, by using Wilczyuski's differential equations of a ruled surface. Dr. Srinivasiengar shows in this paper how these properties can be discussed by means of the theory of correspondence. He considers the correspondence set up on any generator by its intersections with an asymptotic curve, and observing that the torsal generators are generators which touch the asymptotic curve, deduces the results of Wilczyuski and Snyder. The actual equations of the asymptotic curves on the cubic scroll of the first type $x^2z=y^2w$, and on Cayley's cubic scroll $y^3=x(zx+wy)$ have been obtained. These methods are then applied to find the nature of the asymptotic curves of the different types of quartic scrolls.

ON THE AFFINE CLASSIFICATION OF QUADRIC LOCI. *R. Vaidyanathaswamy.* Let $f(x_0, x_1, \ldots\ldots x_n)$ be a real quadratic form of rank r, so that it can be transformed by a real projective transformation into $\epsilon_1 y_1{}^2+\epsilon_2 y_2{}^2+\ldots\ldots+\epsilon_r y_r{}^2$, each ϵ being $\pm$ 1. If s of the ϵ's are equal to $-$ 1, then the smaller of the two numbers $r-s$ and s is called the *signature* of the quadric locus f in projective n-space. Let (r, s) be the rank and signature of the quadric locus Q in S_n and (r_1, s_1) those of Q′, the section of Q by a real prime S_{n-1}. Using these ideas, and taking S_n to be an affine space, and S_{n-1} as the prime at infinity, it is proved that the total number of affine types of quadric loci in S_n is $(n+1)(n+2)$, of which one half are elliptic, and the other half are hyperbolic. The cases for plane geometry and three-dimensional space are exhibited in tabular form.

ON DESMIC TETRAHEDRA. *Nathan Altshiller-Court.* From simple geometrical considerations the following theorems are proved:

(1) The twelve vertices of a desmic group of three tetrahedra may always be considered to be the centres of similitude of four spheres, taken in pairs.

(2) The mid-points of the six segments which the twelve vertices of a desmic group of tetrahedra determine on the six edges of a tetrahedron of the associated group are coplanar.

Indian Chemical Society.

January, 1936.—J. C. GHOSH AND B. B. RAY: *Oxidation of Monochloroacetic Acid by Potassium Permanganate at Wave-Lengths* 366 $\mu\mu$ and 436 $\mu\mu$ *with Uranyl Salt as Photosensitiser.* KALI PADA BASU AND SATI PRASAD MUKHERJEE: *Action of Dye-Stuffs and other Substances on Milk Dehydrogenase. Identity of Schardinger Enzyme with Xanthine Oxidase.* PULIN BIHARI SARKAR: *Electronic Theory of Valency and the Constitution of Aromatic Diazo Compounds.* N. R. DHAR AND S. K. MUKHERJI: *Available Nitrogen in Tropical Soils.* K. C. NAIK AND S. A. VAISHNAV: *Interaction of Sulphur Dichloride with Substances containing the Reactive Methylene Group.—Part II.* K. G. NAIK AND S. A. VAISHNAV: *Interaction of Thionyl Chloride with Substances containing the Reactive Methylene Group.—Part V.* PHULDEO SAHAY VARMA AND S. SHANKARANARAYAN: *Halogenation.—Part XIII. Bromination and Iodination of Some Halogenated Benzenes.* KALI PADA BASU AND MADHAB CHANDRA NATH: *On the Proteinase in the Milky Juice of* Calotropis gigantea. *Its Purification and Activation by Ascorbic Acid and Glutathione.* SACHINDRA NATH ROY: *A Method for the Estimation of Lead Volumetrically by Fajan's Method.* JNANENDRANATH MUKHERJEE, RAMPRASAD MITRA AND NARAYANCHANDRA SEN-GUPTA: *On the Measurement of Absolute Rates of Migration of Ions by the Method of Moving Boundaries.—Part II.* S. M. MEHTA, M. U. PARMAR AND MATA PRASAD: *The Preparation of Thorium Phosphate Gels.* SRISH KUMAR SAHA: *A Modified Micro-Method for the Estimation of Nitrogen in Soil.* M. GOSWAMI AND B. C. DAS-PURKAYASTHA: *Analytical Uses of Nessler's Reagent. A Preliminary Note.*

Meteorological Office Colloquium, Poona.

Three meetings were held during February. At the first of these, held on the 1st February, Mr. Krishna Chanda of the Agra Observatory, gave an account of the experimental investigations undertaken by him recently at the London University under Prof. D. Brunt on the instability phenomena in thin layers of gases. The programme at the other meetings was as follows:—

18—2—1936 Dr. S. K. Banerji—"The theory of development of electric charges on liquid drops and solid particles subjected to various mechanical processes."

25—2—1936 Dr. C. W. B. Normand—"The order of operations in the analysis of weather charts in Norway."

Mr. J. M. Sil—"The history of Standard Barometers in India."

Mr. S. S. Lal—"The Bay of Bengal storm of May 1932."

University and Educational Intelligence.

Mysore University.

1. *Personnel.*—Mr. J. C. Rollo, M.A., J.P., Principal, Maharaja's College, Mysore, was deputed as the representative of the University to attend the annual meeting of the Inter-University Board, India, held at Aligarh.

2. *Extension Lectures.*—The following extension lectures were delivered :—

M. R. Ry. Vaidyaratna G. Srinivasamurti Avl., Principal, Government Indian Medical School, Madras,—(in English) on "Principles of Ayurveda" at Mysore and Bangalore.

3. *Special Lectures.*—Six lectures on "The Rôle of Chromosomes in Inheritance" were delivered by Dr. Eileen J. Macfarlane, Ph.D., D.Sc.(Lond.), at Bangalore. The following is a synopsis of the lectures.

LECTURE I. *Mitosis, Meiosis and Variation.*—The chromosome theory of heredity and the cytological method of attack on genetical problems made possible by it. Cytological conclusions have been arrived at from genetical data and *vice versa*. The work of Newton, Darlington and Belling in interpreting karyokinesis according to the rule that the pairing of chromosomes is a criterion of their homology. The introduction of the statistical and inductive methods into cytology by Darlington. Our present knowledge of chromosome structure and the controversy as to the time of occurrence of the longitudinal split. An outline of chromosome behaviour during the course of vegetative and sexual reproduction in mitosis and meiosis, and the effect on variation in each instance.

LECTURE II. *Cytogenetics.*—Variation as an essential in genetical study, and the importance of choosing favourable material. The characteristics required in an organism by the geneticist, and an appraisal of the relative merits of *Pisum*, *Drosophila* and *Zea*. The value of Mendel's work and the cytological mechanism for his laws. Linkage and crossing-over correlated with chromosome number and chiasma-formation. Mutation of genes and its frequency. How linkage groups were identified with specific chromosomes in *Drosophila* and *Zea*. The work of Morgan, Bridges *et al.*, of Emerson, Anderson, McClintok *et al.* Double cross-overs, compensating chiasmata and "three-point tests". The linear arrangement of the genes. *Zea :* linkage testers ; multiple allelomorphs ; diœcious strains. The effect of X-rays on mutation (Mullur).

LECTURE III. *Hybrids or Heterozygotes.*—The Mendelian-hybrid and the Taxonomic-hybrid. Permanent heterozygotes. Sterility and irregularities of meiosis. Non-disjunction, asynapsis, fragmentation, deficiency and restitution nuclei. Similar irregularities caused by single genes, as shown by Gowans and Beadle, and by X-rays. The work of Blakeslee and Belling on Trisomic *Datura*. The universality of parasynapsis and meiotic prophase chiasmata as a necessity of pairing at first metaphase. Hybrids classified cytologically. Genic unbalance. Fertile interspecific hybrids indicate that the parents differ in minor genetic factors, and retain their identity only by isolation. Fertility of human hybrids.

LECTURE IV. *The Origin and Development of Polyploids and Structural Hybrids.*—An-euploids and euploids. Tetraploids. Auto-polyploids and somatic doubling with reduction of fertility. Allopolyploids or amphidiploids as a source of new fertile races in sterile hybrids of *Triticum*, *Primula*, *Nicotiana*, *Crepis* and *Brassica*. Where this work was done and by whom. Parthenogenesis in polyploid animals and plants. Structural hybrids in which there has been a re-arrangement of genic sequence. Reciprocal translocation is the cause of ring-formation in meiosis, and of semi-sterility. *Œnothera :* non-conformity of genetic data ; inheritance of ring-formation ; lethal combinations ; Twin hybrids ; normal pairing ; the mutations of DeVries. Chiasma-frequency, structural hybridity and sterility in *Rosa*. (Illustrated.)

LECTURE V. *Cyto-Taxonomy.*—The experimental production of wild Linnean species, (*a*) directly by crossing two species (*Rosa*), (*b*) indirectly through amphidiploidy in a sterile species hybrid (*Æsculus*, *Galeopsis*, *Nicotiana*, *Gramineæ* and *Pomoideæ*). Outstanding work of Babcock, *et al.*, on *Crepis* ; the most frequent chromosome number = 4, the most primitive number = 5. Identification of five types of chromosomes by Navashin. Transplant experiments of Hall, *et al.* Reduction of the redundancy of species of *Rosa* in North America through cytological and cultural studies by Erlanson. Parallel variation in *Rosa* and how the species in the section Caninæ are perpetuated sexually as permanent numerical hybrids. The contributions of Boulenger, Hurst and Tackholm.

Andhra University.

Professor Sir Saravapalli Radhakrishnan has been elected to the newly-founded Spalding Professorship of Eastern Religions and Ethics at Oxford. Sir S. Radhakrishnan is the first Indian to be elected to a professorial chair in the University of Oxford. The election is for five years from October 1, 1936.

Reviews.

Praktische Physik. By F. Kohlrausch. New and enlarged 17th edition, edited by F. Henning. (B. G. Teubner, Leipzig and Berlin, 1935.) Pp. x+958 with 512 Figures. Price 32 RM.

The book is a completely revised and enlarged edition of Kohlrausch's well-known work. The authorship, however, is now divided among nineteen authors, all of whom except one are or were in the Physikalisch-Technische Reichsanstalt, Berlin. The size of the book, the style and type of printing and the division and method of handling of the various topics have all been altered. Where originally we had a text-book, of primary interest to the student, we now have a condensed "Handbuch" almost, appealing even more to the research worker and industrial physicist. What strikes one is the immense amount of information given and the consequent condensed treatment. Another pleasing feature is the up-to-dateness: we may cite as examples the inclusion of Ritschl's method of silvering etalon plates, a description of Gehrcke and Lau's Multiplex Interference Spectroscope and a mention of Tomaschek and Schaffernicht's work on the time variation of gravity. The references to original papers are even more up-to-date and helpful, though sometimes, as in connection with the width of spectral lines, an individual author has contented himself with a reference to an old paper. There is, however, one difficulty here: many of the references are to journals not easily available in India since, naturally, German sources of information are cited in preference to those in other languages; but this is not a serious drawback since in all important cases the best sources are indicated without any preference to nationality and language. Another disadvantage to Indian readers is that the apparatus described is in many cases unfamiliar while the more usual varieties do not find a place. Thus we do not find any mention of the methods of determining Young's modulus familiar to us in this country and described in the usual text-books. The descriptions are very often so terse that unless one is already acquainted with the apparatus or method described, it is difficult to follow the procedure. It is therefore clear that an ordinary student cannot use the book as a text-book; in fact ordinary experiments intended for laboratory practice are almost entirely omitted. Only those methods are described in any case, as are susceptible to a high degree of accuracy, and the precautions necessary and the exactitude attainable have been mentioned in most cases. But the research worker will find the work invaluable in showing him what methods are best suited to his needs and giving the essentials of any measurements he might have to make, connected indirectly with his field of investigation; when the description actually given is found inadequate, he will always find a citation to original sources which will solve his difficulty. The industrial physicist will find the book a most useful companion and counsellor. Even the most advanced fields of research such as line and band spectra, X-rays and Radioactivity have found a brief but informative treatment so that whatever requirement the industrial scientist may meet with in connection with his problems, he is sure to find either the information he requires or at least a reference to the best sources of information. We thus find very good sections on the production of high vacua and their measurement or the production and maintenance of any required degree of humidity in any locality, or the insulating properties of dielectrics and the energy losses occurring in them or the methods of measurement in connection with high and low frequency alternating currents. The tables given at the end are also of very great service from this point of view. If sections on photography and glass-blowing are added the usefulness of the book will be still more enhanced. While the student will miss such a common instrument as the sextant, or such a common method as Schuster's for adjusting a spectrometer, and will find only the briefest indication of the procedure in such a case as the determination of the coefficient of cubical expansion of liquids, or the thermal conductivities of substances, the research worker will find descriptions of the methods of determining nuclear spins and isotopic constitution from atomic and molecular spectra. We have occasionally noticed a mis-statement such as the one which says that the method of determining the specific heat of a liquid by cooling depends on the truth of Newton's law of cooling, or the one according to which $\lambda 4916$ of mercury has no satellites. Misprints are even rarer and the get-up of the book is excellent. The

figures are so unusually clear and so generously supplied that it is a pleasure to handle the book. We heartily recommend the book to research workers, industrial physicists and post-graduate students with the confidence that they will never find it wanting when some perplexing problem faces them.

T. S. S.

Atomic Physics. By M. Born. (Blackie and Son, Ltd., 1935.) Pp. 352; Price 17*sh*. 6*d*.

This survey over the vast field of modern atomic Physics is one of the most refreshing, we have read since a long time. It is amazing to see on such an occasion, how our knowledge has spread in the last years and only the existence of this book makes us believe, that it is at all possible to give such a survey in a comparatively not too large volume. In 342 pages Prof. Born has collected a short but complete description of the kinetic theory of gases, radioactivity and isotopes, wave theory of matter, structure of atom and line and X-ray spectra, wavemechanics, quantum theory of the molecules, quantum statistics and structure of molecules, including a mathematical appendix. It is difficult indeed, to give an adequate account of the contents of this book, the abundance of important subjects and interesting discussions makes it difficult to select and to mention any one of them particularly. We cannot, however, resist the temptation of drawing attention to the beautiful simple introduction to matrix mechanics. The matrix is described as nothing else but the most convenient way of tabulating experimental results, as for instance the intensities of spectral lines, according to the various possible transitions between the terms of an atom. If T_1, T_2 ....T_n are the various terms, the possible transitions ν form a two dimensional scheme, in which

$$\begin{array}{l} \nu_{11}, \nu_{12} \cdots\cdots \nu_{1m}, \\ \nu_{21}, \nu_{22} \cdots\cdots \nu_{2m}, \\ \nu_{n1}, \nu_{n2}, \cdots\cdots \nu_{nm}, \end{array}$$

are the single lines of the matrix. Quantum mechanics is now explained as the art, to use a particular mathematical method to calculate with these schemes instead of single quantities.

The book is full of surprisingly simple introductions to subjects, which are ordinarily supposed to be difficult to understand. Often the theoretical physicist gives us a formula without discussing it, leaving the experimentalist guessing as to its true physical meaning. The great charm of this book is that the near connection between experiment and theory is never lost sight of. It is not the mathematical skeleton but the physical meaning of the physical interpretation which again and again is impressed on the reader. This, together with a number of occasional remarks on future developments, make the reading of this volume a very great intellectual pleasure, for which we have to thank its author.

R. S.

High Speed Diesel Engines. By Arthur W. Judge. (Published by Chapman & Hall, London.) Pp. ix+347. Price 15/- net.

At a time when a good deal of original research work is being carried out on the high compression crude Oil Engines with a view to make them suitable for automobile, air-craft and locomotive work on a large scale, a book giving in a concise manner theoretical, practical and descriptive information, about these engines, covering all the experimental work done so far is indeed a necessity and is therefore very welcome. Though the book is entitled "High Speed Diesel Engines," the author refers throughout the book to the engine as compression ignition engine so as to be impartial both to Mr. Achroyd-Stuart and Dr. Diesel who worked on parallel lines on this type of engine.

To bring the compression ignition to the same level as that of a petrol engine, the slow running engine has been developed to a high speed one. Though the cycle on which this type of engine works is the dual cycle, it is shown that by suitably timing the injection of fuel and varying the period of injection, it is possible to follow either constant volume cycle or constant pressure cycle. The modern tendency is to make it approximate more to the constant volume combustion process, thereby getting better fuel economy, more suitable running conditions, and a combustion less sensitive to load fluctuations. From a sleeve valve engine of 15 to 1 compression ratio running at 1300 r. p. m. 53% thermal efficiency has been obtained, as compared with 30 to 34 for well designed petrol engines with compression ratio 5/6 to 1. One other advantage of the compression ignition engine over the petrol engine is brought out by the author from a series of experiments. A 6-cylinder C. I. engine

varying in speed from 600 to 1400 r.p.m. maintains almost constant efficiency throughout and the fuel consumption from less than half torque to full torque over the speed range was always less than ·5 lb. per B.H.P. hour, whereas with petrol engines the fuel consumption is initially much higher at full load and increases progressively as the load is diminished. Reference is also made to tests made with supercharging and curves are given to show (1) that the I.M.E.P. is increased from a maximum of 125 to 160 lbs., (2) that B.M.E.P. is increased from 93 to 130 lbs., (3) that the maximum cylinder pressure increased by 20% (from 550 to 700 lbs.), (4) that the fuel consumption was reduced at part and full loads. Supercharging also gives smoother running and enables higher injection advance angles to be used with good results.

One whole chapter is devoted to comparing the C.I. Engine with the petrol engine. In comparing the author has been fair to both engines, and he has dealt with the disadvantages of the C.I. Engine also.

Also much attention has been given to the phenomenon of Diesel knock which made the C.I. Engine very noisy, in the early stages. From investigations the author shows that this is associated invariably with a high rate of pressure rise during combustion and by regulating the combustion process so as to avoid a too rapid increase in pressure, smooth knockless running is obtained.

The three principal methods of fuel injection, *viz.*, the direct injection method, the pre-combustion chamber method, and the air turbulance method, are discussed in great detail in two chapters and sketches are given to illustrate some typical commercial cylinder heads. The longest chapter in the book is devoted to a detailed study of the two principal methods of fuel injection now popular, *viz.*, the storage system and the jerk pump system, illustrated throughout from actual working engines.

The two cycle C.I. Engine is comparatively more difficult of application to practice due to difficulty of high speed injection at twice the speed of the four stroke cycle, proper elimination of exhaust, prevention of loss of volumetric efficiency, provision of a suitable compressor, and prevention of excessive oil consumption. The constructional details of different makes of two cycle engines are given with a view to show how these defects are partially overcome in each case.

During the past two or three years there has been a fairly rapid and wide development in connection with high speed C.I. Engines for motor vehicles, and engines of many of the leading makers have been described by the author and studied in great detail with a view to bring out the constructional features.

Extending the use of C.I. Engines to air-craft purposes is not only attractive but also desirable from the points of view of safety and economy. The engines are still in the experimental stage, but the chief advantages claimed are, comparative freedom from fire risks, reliability, elimination of source of wireless interference and greater range of light, freedom from carburettor troubles which points are in its favour for commercial cars, etc. A few of the air-craft engines already constructed are shown and the results of tests on them are given. The use of C.I. Engines for stationary and railway work for shunting locomotives, rail coaches and rail cars, express train engines, is illustrated in one chapter.

The last three chapters are devoted to the care and maintenance of high speed engine with special reference to the trouble that are likely to occur and how to cure them and to the selection and use of the fuel oils.

The book is profusely illustrated not only with photos but with sketches which bring out the constructional details and enables one to understand the working better. The results of recent investigations have been condensed and numerous graphs have been included to make the conclusions arrived at clear. The publishers must be congratulated in bringing out the book with few mistakes and with such clear illustrations. On page 38 it is mentioned that loss to the exhaust and by reduction is rather more in the case of C.I. engines, while the figure 16 shows quite the reverse.

The book is a very useful one to engineers and also students as it brings the subject up-to-date and as it contains references to the original papers which make this book a valuable one.

E. K. R.

Theoretische Grundlagen der Organischen Chemie. Volumes I & II. By W. Hückel. (Akad. Verlagsgesellschaft, M. B. H., Leipzig. Second Edition, 1935.) Vol. I: Pp. 475; Price RM. 19·8; Vol. II: Pp. 338; Price RM. 15·6.

These two volumes of W. Hückel's work are not text-books of organic chemistry. We do not find chapters on carbohydrates, aldehydes, etc., but the headings are such as Stereochemistry, Tautomerism, Constitution and Physical properties, Velocities of Reactions and many others. In other words, it is a cross-section through the facts and theories of organic chemistry from a quite unusual angle. Beginning with a development of theoretical concepts of organic chemistry, leading up to electronic theories of valency, the author gives an account of stereochemistry including, *e.g.*, that of N, P, B, and S. The next chapters deal with addition compounds and molecules with anomalous valencies of carbon, particularly free radicals. Six chapters follow, which together form a critical account of those concepts and experiments by which organic chemistry obtains its results, *i.e.*, determines the structure and constitution of organic molecules and the critical remarks appear to be of particular value. The next four chapters deal with physical properties and physical theories and both the Chemist and the Physicist will find some chapters on dipole moments, Raman effect and the theory of dispersion, which constitute the best accounts on these subjects. An account on velocities of reactions forms the last chapter. From this it will be clear, that the author aims at a description and a critical analysis of the present-day theories of chemistry, and this makes the work so valuable. Some of the most important questions of organic chemistry, as for instance the theory of valency or that of side chain reactions, cannot be overcome by purely chemical or purely physical investigations alone, and the methods both of chemistry and physics are needed to solve them. Hückel's book is very well qualified to acquaint the physicist with the method and results of organic chemistry and the chemist with those of molecular physics.

R. S.

The Translocation of Solutes in Plants. By Otis F. Curtis. (McGraw Hill Publishing Company, London, 1935.) Pp. ix + 273. Price 18*s*.

Every branch of science has presented certain difficult and fundamentally important aspects which have continued to remain either obscure or controversial in spite of the devoted efforts of a number of investigators. Such efforts defy complete solution more on account of the deficient state of our technique in that particular branch of the subject; a new impetus is often given to the investigation either by the discovery of some new technique applicable to the study of the problem in question or by a careful and critical presentation of the problem after discussing the several points of view. Such a presentation attains special significance when the task is accomplished by one who has contributed substantially to the advancement of the subject.

The present volume on the Translocation of Solutes in Plants by Otis F. Curtis deals with an aspect of plant physiology which is of fundamental interest. Commencing with a discussion of the earlier opinions regarding the tissues involved in the upward and downward transfer of solutes, the author proceeds to present experimental evidence in support of the upward transport of organic matter through the phlœm, and in this connection he has invoked the aid of the ringing experiments particularly those of Dixon, Mason and Maskell and others. The main objection to all such experiments is that the physiological injury inflicted on the organism in the process of experimentation, introduces responses abnormal to the plant. But in absence of any finer technique, there appears to be no other alternative. Progress in this field is therefore closely connected with the progress of science in other allied branches of science which may be helpful in evolving new methods of investigation.

The author and the publishers have done a service in bringing to the forefront a problem of the greatest interest in the domain of plant physiology. It is hoped that the book will stimulate new and vigorous research activity in this field.

M. S.

The Beginnings of Plant Hybridization. By Conway Zirkle. (University of Pennsylvania Press, Philadelphia. Humphrey Milford, Oxford University Press, London. 1935.) Pp. xii + 231. Price 11 *sh.*

This is the first of a series of monographs to be issued by the Morris Arboretum, University of Pennsylvania founded by Miss Lydia Thompson Morris "for the increase of knowledge through research and the communication of knowledge through publication." The author is the Geneticist at the Arboretum and Associate Professor of Botany, University of Pennsylvania. The book is

well got up and the few illustrations, some of them from rare sources, add greatly to the value and attractiveness of the book.

In this monograph the author gives fairly detailed references to the work of plant breeders of the eighteenth century and before the publications of Koelreuter (1761–64). An examination of extant literature showed that such work was little recognised, even the great work of Sachs being defective in this respect; hence this attempt to fill up the gap. As many as thirty researchers previous to Koelreuter are mentioned and their contributions briefly reviewed. They include such names as Cotton Mather, Thomas Fairchild, William Knowlton, Philip Miller, Paul Dudley, Johannes Haartman and Carolus Linnæs.

The bulk of the book reads like a novel and it is interesting to be told of decorative Assyrian and Babylonian art depicting cherubs in the act of pollinating date palms. The book takes us back to the dim remote past when attempts at hybridization were considered impious and an "insult and outrage" on the Creator. The mule was one of the first to be recognized as hybrid and beliefs used to be current about phantastic hybrid creations such as between the eel and the viper, the panther and the lion and between man and the bear. The very curious shapes of certain mythological animals must have risen from such beliefs.

The diœcious date palm and the monœcious *Zea Mays* (the Indian corn) were the first to suggest to man the idea of sex in plants. Dates were hand pollinated during Babylonian times with the object of increasing crop production and the suggestion is made that the art of hand pollination "possibly anti-dated the invention of writing". The mule which has "neither pride of ancestry (because of its hybrid and hence disreputable origin) nor hope of descendants (being sterile) is mentioned several times in the Odyssey. Angels, it was believed, occasionally descended to the earth and from their matings with human beings arose the great warriors of mythical times, whose great prowess and strength found an easy explanation in such origin.

In prehistoric times even the precious stones were grouped into the two opposite sexes and were thus capable of multiplying themselves. During the Assyrian period plants were also divided into "male" and "female" according to their size and hardness. This reminds one of the classification of plants like the *Saccharum* into "male," "female" and "neuter" according to Indian medical science. During the eighth to tenth centuries the Arabian Natural History was superior to the European, though in itself highly speculative and romantic. Hybrids occurring in nature were often attributed to a degeneration of the species and the transmutation of one species to another, such as wheat into oats and rye into barley, was widely believed.

We may have to recognise Ibn-al-awwam (1150 to 1200 A.D.), the Arabian scientist, as perhaps the first Plant hybridiser of the world; he carefully describes the effect of foreign pollen on plant progeny and had certainly carried out hand pollination in the date palm. Yet another Arabian scientist Abd-al-Latif (1162 to 1231 A.D.) reported hybrids between the orange and the lemon. The first real intimation that hybrid plants could be secured by cross pollination came, however, from Camerius (1694) but he was chiefly interested in plant hybridization as a proof that plants also reproduced sexually like animals.

The Indian corn (*Zea Mays*) looms prominent in the early records of plant hybridization owing to the obvious effects of foreign pollination (xenia). It was the first plant in which the effects of hybridization were early recognized and even to this day its hereditary factors or *genes* are known better than in most other plants. The book gives in some detail the work of various plant breeders from Cotton Mather (1716) to Koelreuter (1764) and a useful bibliography is added at the end.

Though the book may not be of much use in current work on Plant genetics or hybridization—no such claim is made by the author—it gives the reader a very rare and interesting glimpse into the dim prehistoric and historic past and this is both stimulating and exhilarating. It gives the correct and much needed background for understanding the "beginnings of plant hybridization".

A Description of the Physiological Laboratories of the Institute of Animal Husbandry, Leningrad. Edited by M. M. Lawadowsky. (Lenin Academy of Agricultural Sciences, Leningrad, 1935.) Pp. 252.

One has often heard in recent years of the advances being made in the U. S. S. R. in the development of Animal Husbandry in

that country, but in the absence of any opportunity to visit it, one has had to rely on publications to obtain any detailed information in regard to the progress that is being made.

In this case, however, the language difficulty often arises and it is, therefore, of considerable interest to find a publication, such as that now under review, which although written in Russian has alongside the original text a very readable translation in English.

This publication was prepared for presentation to the XV International Physiological Congress by the All-Union Institute of Animal Husbandry of the Lenin Academy of Agricultural Sciences, Leningrad, and consists of some general remarks under the heading "Science and Animal Breeding" by the Director of the Institute and six other articles dealing in more detail with such subjects as the Dynamics of the Development of the Organism, Experimental Endocrinology, Artificial Insemination, the Physiology of Digestion, the Physiology of Lactation and Biochemical Studies of Straw and other Foodstuffs.

Perhaps the most striking section is that written by the Director, who explains the problems which confront Animal Husbandry workers in the U. S. S. R. and gives an indication of the way it is proposed to tackle them. He commences by pointing out that because of the efforts that are being made to transform the country from a backward agricultural to an industrial one, the animal industry is confronted with a clear cut task of increasing the quantity of animal products, improving their quality and lowering the cost of production.

During the Second Five Year Plan it is proposed to increase the number of horses by 11·2%, cattle 61·1%, sheep 88·1%, and pigs 274·2%, and it is pointed out that to effect this enormously rapid rate of increase without lowering the quality of the produce it will be necessary to work along new lines founded on scientific data, which can only be obtained from a network of scientific research institutions, which it is hoped will rapidly find methods of protecting the existing herds from infectious diseases, provide for the proper conditions of maintenance to prevent sickness, determine the conditions necessary for obtaining an increase in such animal husbandry products as meat, wool, milk, eggs, etc., and work out satisfactory methods for grading up pure-bred herds.

In the U. S. S. R. there are at present 126 such scientific centres at which about 6,000 specialists are working at various problems connected with zootechnics, veterinary medicine and food production and the All-Union Institute of Animal Husbandry at Leningrad is one of the most important in this chain. Other All-Union Institutes deal with Acclimatization and Hybridization, Veterinary Research and Horse-breeding, while there are a number of subsidiary research institutes which deal with more specialized branches of Animal Husbandry, such as Sheep breeding, Poultry breeding, Bee-keeping, Rabbit breeding, Sericulture, Helminthology, etc. In addition a system of zootechnical stations financed by local funds and farm laboratories, which already number 20,000, have been set up to work in collaboration with the larger institutes.

The chief lines of work at the All-Union Institute of Animal Husbandry may be classified under the following heads:— Experimental breeding, Artificial Insemination, Physiology of Reproduction, Nutrition and Increasing the productivity of Farm Animals. To carry out these duties 16 separate laboratories have been provided and it is said that other institutes are furnished on a similarly lavish scale.

Turning to the more detailed part of work there is much to interest Indian readers. The subject in which perhaps the greatest advance has so far been made is that of artificial insemination which, when correctly used, widens the possibilities of livestock improvement by extending the use of valuable sires, allowing a study of the laws of inheritance in farm animals and experiments in hybridization, with the aim of producing new breeds. The use of this method in the field in the U. S. S. R. is said to have been particularly successful in sheep, in which species 5,000 ewes may be impregnated with the sperm from one ram, while even in cattle 2,000 cows may be inseminated from one sire.

Zootechnical endocrinology, the name given to a new branch of science dealing with the part that internal secretions play in the reproduction processes of the domestic animals, has also produced some striking results, particularly in connection with the production of artificial œstrus and ovulation, and the increase of fertility. As examples may be quoted the case of certain breeds of sheep, whose lambs are destroyed at birth for the sake of their pelt, being made

to produce young at double the rate than formerly, and the use of ovary-lyzates, *i.e.*, products of the primary disintegration of ovarian tissue, on hens, in which a 30 % increase in egg production is said to result within 4–6 weeks after each injection.

In connection with lactation in the cow good results have been obtained both with the products of the acid hydrolysis of fibrin and an alkaline extract of the anterior pituitary body, and in the case of the latter not only was the milk yield improved but there was also an increase in the fat content.

Altogether this is a most stimulating publication, and well worth perusal by any-one interested in the development of Animal Husbandry in India, for it shows very clearly what might be done, particularly in connection with those subjects which in the English Language are usually included in the term "Applied Animal Genetics," to improve the livestock industry of this country.

F. W.

Commercial Marine Fishes of South Africa. (Fisheries Bulletin No. 2. Fisheries and Marine Biological Survey Division, Department of Commerce and Industries, Union of South Africa, Pretoria.) Pp. 160. Price 5 *sh*.

Students of ichthyology interested in the marine fish fauna of South Africa are already familiar with the admirable and indispensable work of Dr. K. H. Barnard entitled *A Monograph of the Marine Fishes of South Africa*, but to meet the requirements of professional fishermen, anglers, those interested in the fishing industry and amateur naturalists a handbook embracing semi-technical descriptions and illustrations of the commoner commercial fishes occurring in the seas of South Africa has now been published. This much-needed work has been produced by Mr. J. M. Marchand, Technical Assistant to the Survey Division and is entitled *The South African Marine Fishes of Commercial and Angling Importance.*

The book is divided into two parts, dealing with cartilaginous and bony fishes respectively. In the list that precedes the general account common and scientific names of the species dealt with are given ; this is followed by 7 outline illustrations intended to explain anatomical terms ; a glossary of anatomical and descriptive terms is given and then there is the systematic account of the various species which are arranged into families and genera mainly in accordance with Jordan's system of classification. Under the account of each species attention is directed to its taxonomy, chief characteristics, distribution, fishing season, commercial importance and the fishing-gear used in catching it. Each species is illustrated with a good photograph, mostly taken by the author himself from fresh specimens. In an appendix explanatory notes on names and types of fishing-gear are given and in the concluding section the meaning and use of scientific nomenclature are explained. The work contains an index of all names, commoner and scientific names of fish and of fishing-gear, and for convenience of reference the scientific names of genera and species are given in italics.

The value of such a work cannot be over-estimated in so far as it provides a ready means of determining fishes in the field and of knowing the precise significance of one's catches. A handbook like this is sure to bring in more information about the species from quite unexpected sources, resulting in the advancement of knowledge regarding the habits and habitats of commercial fishes. The author and the department are to be congratulated on the production of such a useful and valuable work. A similar work on Indian fishes is badly needed for the development of fisheries in this country.

S. L. H.

Annual Report, 1934-35. Department of Industries, Bombay Presidency. (Printed at the Government Central Press, Bombay. 1935.) Pp. 50. Price 4 As. or 5 *d*.

This publication deals with all the activities of the Department of Industries during the year. The *Report* assumes considerable importance when it is remembered that industrially, Bombay is the most advanced part of India.

The first part dealing with the state of some important industries like Glass, Chemicals, Silk, Gas Mantles, Aluminium and Gold Thread makes very disheartening reading as the trade depression affecting all industries in general, continued. It is encouraging to note, however, that Cotton Textile Industry outside the island of Bombay, Woollen Industry and Sugar Industry registered improvement.

The information given in the next section dealing with new enterprises such as rerolling

steel mills, manufacture of canvas shoes, metal printing and manufacture of centrifugal pumps, oil engines, tricycles, perambulators, dry cells, bakelite and small electrical motors is rather more encouraging.

The activities of the Department are next dealt with. We note with interest that practical investigations, experiments and demonstrations for possible new industries were conducted and the lines tackled included Peppermint Oil, Lemon Oil, Alumina and Aluminium Sulphate, Mango Pulp, etc. Investigations on some Cottage Industries like Oil Industry, Pottery Glazing, Hemp Industry, Bone-manure and Glass-bangle Industry were also on hand.

It is stated in the *Report* that a summary of the progress of Scientific and Industrial Research during 1934–35 was sent to the Government of India for inclusion in the Annual Report of the Committee of the Privy Council for Scientific and Industrial Research, London. No indication is given that these results are published elsewhere. After all, the work done by the Department is primarily for the benefit of the Industrialists in India and one is entitled reasonably to expect that the results of all the scientific investigations conducted under its auspices would be published in detail in India as is being done by the Government of H. E. H. The Nizam of Hyderabad and other Provincial Governments.

K. A. N. R.

Electrochemistry, Vol. II. Applications. by W. A. Koehler. (John Wilby & Sons, New York; Chapman & Hall, London. 1935.) Pp. xiv + 545. Price 25/-

The publication of this book by Professor Koehler has removed a long-felt want for a suitable and *up-to-date* text-book on Applied Electrochemistry. The author has succeeded well in the difficult task of making the book sufficiently complete and up-to-date without at the same time making it too voluminous for the use of colleges and technical schools. This has been made possible by a very judicious selection of materials, and by a concise but lucid style of exposition. A large number of well-arranged and neat diagrams has enhanced the value of the book, and has materially contributed to a clear understanding of the subject. As is to be expected, the chapters on storage batteries, electroplating, electro-metallurgy, and the electrical processes for the manufacture of chemicals are fairly comprehensive. The author has also discussed the problems of corrosion, electroanalysis, separation of materials by electrostatic and electromagnetic devices, thermionic and electrolytic rectification, the possible industrial uses of photoelectric and photovoltaic cells, and even the electrolytic process for the preparation of Deuterium.

The price of 25/- is perhaps a little too high for Indian students, but the reviewer has no hesitation in recommending it to every serious student of electrochemistry.

J. C. G.

Erratum.

Vol. IV, No. 7, p. 494, in the table under the heading Percentages in groups, *Read* 62·40 *for* 60·40.

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CONTENTS.

The New Viceroy and Science.

WE have pleasure in offering our warmest felicitations and welcome to Lord Linlithgow whose appointment to the Viceroyalty of India is received with general satisfaction. His Lordship had exceptional opportunities intimately to study the political and economic conditions of this great country, and we hope that during his period of administration there will be peaceful and rapid progress in the achievement of the great ideals for which the nation is hungering. The problems which must immediately engage the attention of the new Viceroy must necessarily refer to the constitutional relationship of India with Great Britain, and probably the ceremonial arrangements connected with the Coronation of H. M. King Edward VIII in New Delhi. The successful inauguration of the New Reforms Act, arduous and difficult in itself, and the organisation of a historic pageantry, would under any circumstances entitle the Viceroy's administration to great praise; but the political, financial and economic developments, that have occurred in India since the introduction of Reforms in 1919, have so profoundly modified the outlook of the people, and have brought into existence conditions of life, that a solution of the more outstanding problems seems equally urgent. At the farewell dinner given by the Combined Empire Societies on the eve of his departure to India, Lord Linlithgow recalled his labours as Chairman of the Agricultural Commission and referred to unemployment, which together are fraught with possibilities far transcending in importance the issue of political evolution of this vast sub-continent. Few Viceroys have been called upon to assume the responsibilities of their exalted office in circumstances more critical than those which confront Lord Linlithgow, and the problems which await solution are not, however, beyond his statesmanship.

The welfare and prosperity of the people depend on the extent to which the country is scientifically organised, and our firm conviction is that unless the major industry of the people persistently applies scientific method and scientific knowledge to its problems, it cannot escape from the difficulties with which it is surrounded. In the field of science, therefore, no Legislature can reasonably recommend measures of economy which will sacrifice the efficiency of research

organisation. The Royal Commission on Agriculture have pointed out that "in spite of marked progress which has been made in many directions during the last quarter of a century, it is hardly an exaggeration to say agricultural research in this country is still in its infancy. The claims of research have received a half-hearted recognition and the importance of its efficient organisation and conduct is still little understood." On the recommendation of the Commission the Imperial Council of Agricultural Research was established, and in the beginning of last year, the Industrial Intelligence and Research Bureau was founded. By a judicious system of grants-in-aid and a careful selection of problems, the Imperial Council of Agricultural Research has promoted fundamental enquiries in agriculture in the universities and other research centres. The Industrial Intelligence and Research Bureau, which is attached to the Indian Stores Department, has, through its Advisory Council, formulated a series of problems in the fields of Chemistry and Engineering, for investigation at the Government Test House, Alipore. While we recognise the magnitude and the importance of work initiated by these bodies, we feel that the task of extending and consolidating national research activities could go steadily forward only under the auspices of a National Advisory Council of Scientific Research. There are now in Great Britain under the direction of the Department of Scientific and Industrial Research, 24 research associations in which the Department and industries co-operate, seven research institutions controlled and supported solely by the Department, which have been formed for the study of special industrial problems and 40 research stations dealing with agriculture or industry, some privately and some publicly controlled, whose function is to promote industrial developments. Many of these stations are connected with the universities of the country and receive subventions from Government. These are significant illustrations of what is going on over the whole of Europe including Russia, where scientific research is being intensively organised. It seems to us that simultaneously with the inauguration of constitutional reforms, an announcement should be made in regard to the establishment of the National Advisory Council of Scientific Research for the purpose of co-ordinating all the research organisations in order to promote a steady advancement of the industrial prosperity.

The principal task of such an institution will be to emphasise that no industry can afford in these times to neglect any opportunity for increasing its efficiency and, of all the means to this end, the pursuit of research and the applications of the results obtained are often the most far-reaching and fruitful. If the case for research on the production of Indian commodities is as strong as ever, the need for research into their utilisation is stronger still. In nearly every industry to-day, movements are on foot to apply old materials to new uses, and to discover uses for new material. Cotton, wool, rubber, food products and alloys of metals are instances in point. Whether the object in view be to create a wide demand for a commodity and thus reap the advantages of modern methods of production or to discover the most suitable material for a particular purpose, it is equally important that the chemical and physical properties of the materials concerned should be fully understood. For investigations of this kind, the facilities in the laboratories of the universities and in those of the Indian Institute of Science, if extended and supported by increased grants from the funds of the National Advisory Council of Scientific Research will be found ample for industrial research of the highest quality.

As part of the general policy of concentrating attack upon problems of immediate importance both to science and industry, Government should revise its scheme of award of subventions to research work conducted either under private or government auspices. The wider control which the Legislatures will soon acquire under the reformed constitution over the administration of public finance, will also provide increasing opportunities for the promotion of scientific research, without which Indian industries can never compete with the better organised European countries. The Government of India and the Indian Congress have individually launched a campaign for the welfare of villages and the betterment of village life, and large sums of money are proposed to be spent on the establishment of happier conditions in the village organisations. Almost every aspect of rural problem has a scientific bearing, and it must be obvious to any reflecting mind that a scientific enquiry into conditions of village

life should precede measures for their amelioration. Agricultural practice is only one aspect of rural science, which includes a veterinary side, animal and plant genetics, village economy and cottage industry, sanitation and water supply and building and road construction materials. The resources of governments and of other agents should not be fritted away by embarking upon empirical schemes of modernising villages, but should be devoted to the study of carefully planned investigations of the biological and economical features of the problems, on the results of which proposals of betterment should be based. Schemes for the improvement of villages will be permanent only if the rural population can appreciate their benefits, and if the individual members are sufficiently educated to support and improve the reforms. The rural commodities furnish the necessary materials for large-scale industries, and their continuous supply of the right kind involves a closer study of all raw goods by the producers themselves with such co-operation of the outside scientific expert as may be available. The village community must develop a scientific turn of mind before its welfare and prosperity could become the assured source of additional public revenue.

In reviewing the possibilities of developing rural science or expanding the industrial investigations, what emerges most clearly is the importance of provision for an effective programme of laboratory work in the Scientific Surveys, Universities, the Indian Institute of Science and Government Research Stations. In the laboratory the research worker is free from those obligations inevitable when experimental work on a large scale has to be planned, while intensive laboratory work affords the best way of understanding the root problems which may lead to improvements of relatively minor nature in the existing processes or to suggestions for alteration in production or in methods of utilising raw materials. One of the tasks of the reformed administration ought to be to foster close relations between laboratory work and industries, for on the extent of such co-operation depends the entire fabric of human civilisation. The most effective criterion of the value of laboratory research is the extent and direction in which the results are put into practice, but the application of the results is difficult to ensure unless industry is prepared to take a vital interest in the research work. The contact can become real and yield far-reaching benefits only when the new Legislatures recognise its superlative importance as a means of creating wealth, and provide in their annual budgets adequate grants for all private and public research institutions. The inauguration of constitutional reforms and their successful working may bring political contentment or may foster a new movement for further instalment of reforms, and the wisdom and public spirit with which they are brought into being, must also recognise that a decorated political vesture can only add to national dignity, but scientific organisation enriches and supports the life-blood of the country. The poverty and backwardness of India can be removed only by investing more money in the promotion of scientific research and if, in the midst of his political concerns and duties, His Excellency Lord Linlithgow could bestow some attention on the imperative need of consolidating the work of the Royal Commission over which he so worthily and ably presided, his contribution to the lasting happiness and prosperity of India would be such as few Viceroys have conceived or achieved. To watch and guide the working of the New Reforms Act is part of the routine programme of the Viceroy's duties, but to devise a scientific organisation of this great country "as a means of assisting the advance of the rural community towards a richer and fuller life, and of awakening the desire in that community for better things and arming each individual member of it against the temptations that beset him, without impairing either his self-respect or his spirit of manly independence," calls for the active and generous exercise of those higher qualities of statesmanship with which Nature and political training have abundantly endowed Lord Linlithgow.

The Physiology and Chemistry of the Plant Hormones.

By Kenneth V. Thimann.

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IT is now some 17 years since A. Paál published a paper in Germany on phototropic reactions in grass seedlings, and in the course of that time his results have led to the development of a new field in plant physiology. Paál set out to confirm the findings of Boysen-Jensen on the phototropism of the Avena coleoptile. Boysen-Jensen's experiment was to remove the tip of the coleoptile and stick it on again with gelatin; on subsequently illuminating from one side, phototropic curvatures appeared, not only in the tip but also in the part below the cut. It followed that the tip had some power of making the lower part of the coleoptile light-sensitive. In the course of his experiments Paál not only confirmed this, but also found that it was sufficient to replace the tip somewhat to one side to obtain a marked curvature away from the applied tip, even in darkness (see Fig. 1 *a*).

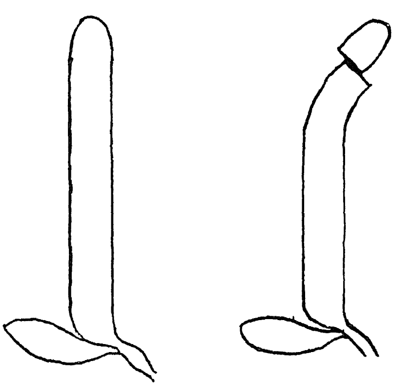


Fig. 1(*a*).

Curvature produced by unilateral replacement of tip.

Hence the tip promotes the growth of the part below it. This was confirmed in 1925, by Söding, who measured the straight growth with a travelling microscope; after decapitation the growth of the coleoptiles fell to a small fraction of its normal value, but on replacement of the tip it was increased. This experiment can only be carried out over short periods of time, since after about 3 hours growth increases spontaneously again; this is the so-called "regeneration of the physiological tip" by the uppermost part of the stump. This effect need not concern us here.

Stark attempted to extract the growth-promoting substance by crushing a number of tips and mixing them with gelatin or agar; the gel was then cut up and small pieces applied to one side of decapitated coleoptiles (Fig. 1 *b*). The results were negative.

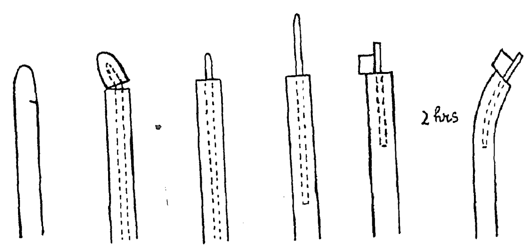


Fig. 1(*b*).

B. Went's technique for *Avena* curvatures. The primary leaf is pulled out and cut off, a part being left in as support for the agar block.

However, his student, Seubert, showed that blocks of agar containing saliva, diastase or malt extract, so applied, produced large curvatures in this way. Went (1928) then showed that if intact tips were placed upon agar, the growth-promoting substance diffuses out into the gel, which if now applied one-sidedly to decapitated coleoptiles caused marked curvatures. Instead of merely recording the number of plants curved he measured the angle of curvature and showed that, within limits, it was proportional to the number of tips which had stood upon the agar block. This enabled quantitative determination of the relative amounts of the substance present to be made, and this laid the foundation for subsequent work. On this basis Went determined that the amount of the substance produced per tip per hour remained constant for some hours. He also determined the molecular weight of the substance by the diffusion method, and found it to be 376, *i.e.*, the substance is a relatively small molecule.

That a non-specific growth-promoting effect is here involved was shown by Cholodny, who placed tips of *mais* within a bored-out stem of *lupinus*; they promoted

its growth. Much subsequent work has shown that the action of the growth substance is completely non-specific within the higher plants.

Cholodny put forward the theory that if the growth of the coleoptile was due to a growth-promoting substance, then its *asymmetric* growth must be due to an asymmetric distribution of this substance. In other words, curvatures such as those exhibited in phototropism and geotropism must be caused by the active substance becoming concentrated on one side as a result of the action of the light or gravity. The truth of this view was proven experimentally by allowing the substance to diffuse out into separate blocks at the base of the coleoptile; Went showed that on unilateral illumination more growth-promoting substance came from the shaded (S) than from the lighted (B) side;—correspondingly the plant curves *towards* the light; Dolk (1930) found that on placing the coleoptile horizontally more growth substance came from the lower (L) than from the upper (U) side; (see Fig. 2). The essential mechanism of

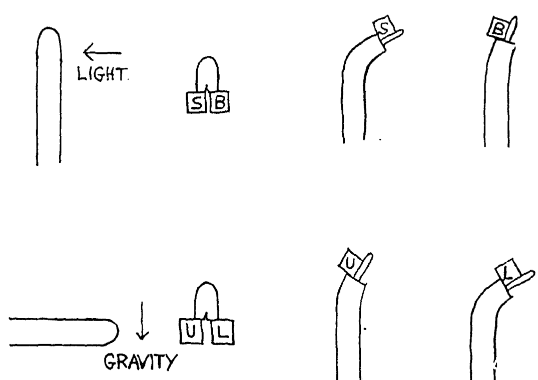


Fig. 2.

Asymmetric distribution of growth hormone in tropisms. The shaded side, S, and the bright side, B, are allowed to diffuse into separate agar blocks. The former gives the larger curvature in the subsequent test. With gravity the upper side, U, and lower side, L, are similarly treated; the latter gives the larger curvature subsequently.

geotropic and phototropic response is thus explained, though the latter is complicated by the "light-growth reaction" of Blaauw. The various factors in phototropism need not be discussed here, for they have been reviewed in detail by du Buy and Nuernbergk (1932–35).

The use of Avena curvatures as a standard test for growth-promotion depends upon the fact that curvature is proportional to the concentration applied up to a certain limit,—the "maximum angle", which is usually about 20°; similarly in straight growth the growth produced is proportional to the concentration applied bi-laterally within somewhat wider limits, but here too there is a maximum concentration above which there is no further response (see Fig. 3, from Thimann and Bonner, 1933).

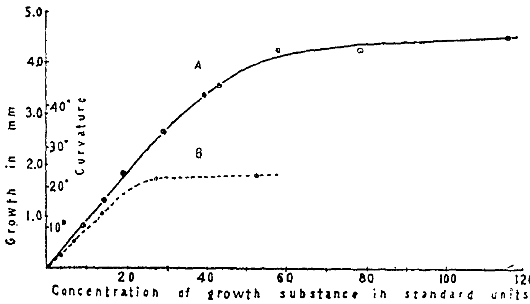


Fig. 3.

Amount of growth resulting from different quantities of growth substance.

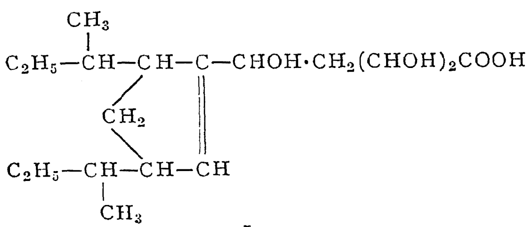
Curve A, vertical growth; curve B, curved growth.

The next step, of course, was to discover the chemical nature of the active substances or hormones. Nielsen, in 1930, made the first step towards this by finding that the medium on which certain moulds had grown was rich in a substance promoting coleoptile growth, and that the substance was soluble in ether. Dolk and Thimann (1931) made large-scale preparations of the substance from mould cultures, and found that it was extracted by ether only from acid solutions, *i.e.*, the substance is itself an acid. By shaking out at different pH the dissociation constant of the acid was determined as $1{\cdot}8 \times 10^{-5}$, *i.e.*, about that of acetic acid. The sensitivity to H_2O_2 and other mild oxidising agents indicated the substance was unsaturated. The limiting detectable curvature was found to be produced by 7×10^{-6} mg., of the concentrated syrup.

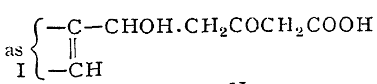
The same growth-promoting action was also found in human urine by Kögl, Haagen-Smit and Erxleben (1931, 1933), and from the ether extract of acidified urine they succeeded in crystallising an acid, $C_{18}H_{32}O_5$, m.p. 196°. It formed a lactone, which is also active, and contained a total of 3 OH groups; the molecular weight, 328, agrees satisfactorily with that found by Went for the substance in the coleoptile tip, but of course this does not prove the identity of the two

substances. From malt and from maize germ oil was isolated another acid, $C_{18}H_{30}O_4$ *i.e.*, isomeric with the lactone above. The breakdown experiments of Kögl and his collaborators have shown that the former substance, "auxin A, or auxentriolic acid ", has formula I, while the other, " auxin B, or auxenolonic acid" is the corresponding β-keto-acid, formula II.

However, many other substances possess the same growth-promoting activity. Kögl and co-workers found that a large part of the activity of urine was due not to the above " auxins ", but to a third substance, indole-3-acetic acid (formula III), a substance known as a product of bacterial breakdown of proteins. This acid is highly



I



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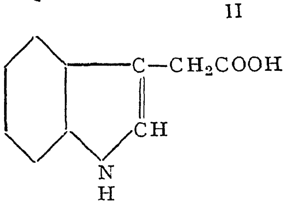
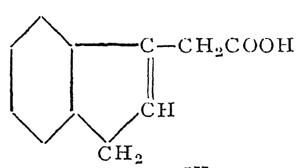


III

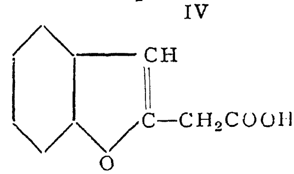
active; in terms of curvature on *Avena* under standard conditions its activity is from 50–70% of that of " auxin A and B"; of the latter a curvature of 1° is produced by the application in agar of $2 \cdot 10^{-8}$ mg., an extraordinarily high activity. The writer has shown (1935) that the growth-promoting substance produced by mould cultures is also indole-3-acetic acid. It is formed principally in the presence of peptone, and the yields depend upon the tryptophane content of the peptone; they also vary with the aeration given to the culture, since conversion of tryptophane to indole-3-acetic acid is an oxidative process. Kögl and Kostermans have tested the activity of a number of derivatives of indole-3-acetic acid and many of them are active, though none has more than 20% of the activity of the mother substance.

Before discussing other developments in this direction it is necessary to consider the nature of the growth-promoting action. If the substance is applied to the apical end of a section of a coleoptile, it is transported rapidly to the basal end, and may be found there if an agar block be applied to the basal cut surface. If, however, conditions are reversed and the substance is applied at the base, none appears at the apical end. The phenomenon is independent of gravity. This very remarkable polar transport was studied by van der Wey (1932, 1934) who showed that it is reversibly suspended in presence of narcotic vapours. Similar polarity exists in young bean and pea stems and other research material. The combination of this concept of polarity with the unilateral transport which occurs in tropistic growth or when the growth substance is applied to one side only gives a picture of the normal transport as a strictly " apex to base " affair; any molecule, whatever its position, will be carried towards the base, not across or up the plant, independent of gravity or of the gradient of the growth substance.

Clearly, if a substance applied in agar were to spread out across the plant it would produce no curvature, even though it might promote the growth. If it did not spread out, but was transported less rapidly than the naturally-occurring growth substance, it would produce a curvature, but only for a short distance below the point of application. Both these effects have recently been realised by the writer (1935), with two analogues of indole-3-acetic acid. The substance IV, which is indene-3-acetic acid, produces curvatures only over a short

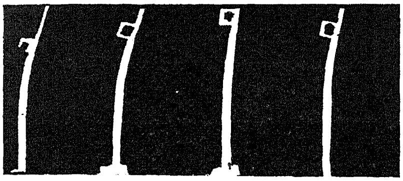


IV

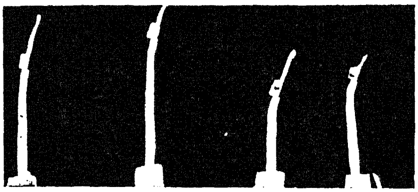


V

distance (see Fig. 4), while substance V, coumaryl-1-acetic acid, produces no curvature at all; both promote growth of *Avena* strongly, however, as tested by straight growth, although they are not as active as



INDOLE



INDENE

Fig. 4.

Curvatures caused by indole-acetic acid, readily transported, compared with localised curvatures due to indene-acetic acid, poorly transported.

compounds I, II and III; they also produce growth and curvature in pea stems. It is clear, therefore, that we must distinguish between growth-promoting action as such and the faculty of being transported in the plant, and compounds may possess one property without the other. These considerations open up new possibilities for investigating the mechanism of the action. It is interesting to note that Went and Haagen-Smit have recently tested a large number of other compounds for growth-promoting activity, and have found some other compounds which behave like the two above. Thus atrolactic acid, like V, does not produce *Avena* curvature although it promotes straight growth, while allocinnamic acid resembles IV in producing a curvature which is limited to a small zone close to the point of application.

The fundamental problem of the mechanism of the action of the hormones, while it may perhaps be approached by chemical methods making use of compounds like III, IV and V, is still very far from solution. The work of Heyn has shown that coleoptiles, and some other suitable objects like tulip-stems, become more plastically deformable if they have been first treated with auxin.* A rider placed upon a coleoptile causes a greater degree of irreversible bending in presence of auxin than without it, and the response of decapitated coleoptiles increases after regeneration of the physiological tip. Hence one effect of the substances is to increase the plasticity of the tissue, and this presumably allows osmotic forces to stretch the cell-walls irreversibly. Even if this view is true,—and it is still in dispute,—the difficulty remains that the number of molecules of auxin entering the tissue is far too small to have any stoichiometrical relation with any of the wall constituents. The data of Thimann and Bonner show that one molecule of indole-acetic acid gives rise to the formation of 3×10^5 hexose units as cellulose, and a correspondingly large number of pectin, protein, hemicellulose and other molecules. In order for auxin to have its effect, the tissue must be respiring; Bonner showed that if respiration be partly inhibited by HCN, growth is inhibited to the same extent. An oxidative process is therefore involved in growth. Another interesting fact is that the auxin disappears in the growth process; within limits the amount disappearing is proportional to the growth produced, but if excess is applied most of it is destroyed in the tissues without causing proportional growth. Since it disappears also in presence of HCN the disappearance cannot be by the oxidative reaction mentioned above, and must hence involve yet another process. It is thus clear that the reaction in which auxin takes part is only the first of a chain, the last member of which may cause the increase in plasticity and so give rise to growth.

It will now be necessary to digress somewhat. It was the view of Sachs that the various organs of a plant are each formed under the control of a special substance, and the classic experiments of Vöchting showed that root formation in particular is a polar phenomenon, roots being mainly formed at the morphological base of a cutting. The exceptions which form roots all over have ready-formed root initials, and apart from these Van der Lek's (later) experiments show that roots are formed in a strictly polar manner, and largely under the influence of buds and leaves. These phenomena strongly suggest hormonal action, and Bouillene and Went proved that a substance of some kind is really involved because water in which leaves had stood possesses root-forming activity. Commercial diastase has the same effect. The nature of this root-forming hormone was studied by Thimann and Went; it was found to have all the properties of the auxins; on purification

* The term is used in a general non-chemical sense as 'growth substance'.

the growth-promoting activity followed parallel to the root-forming activity; finally they showed that pure auxin A and B and indole-acetic acid are tremendously active in forming roots, only 10^{-5} mg., being needed to form 1 root on the pea stems used. Laibach and co-workers also found pollen and urine, rich sources of growth substances, to have root-forming activity. These compounds, I, II and III, therefore, give rise not only to growth by cell extension but also to root formation,—two apparently unrelated physiological processes. Root formation usually begins with cell divisions. Root formation, like growth promotion, seems to be highly non-specific, peas, beans, lemons (see Fig. 5), marigolds, figs, *tradescantia*,

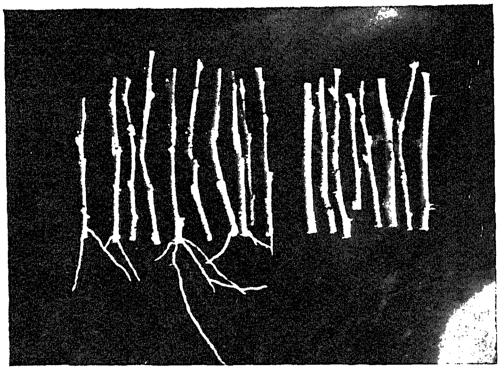


Fig. 5.

Leafless lemon twigs; left, treated (indole-acetic acid in lanoline); right untreated. After one week in moist sand. (Courtesy of W. C. Cooper.)

acalypha and *nicotiana* all respond well; the use of hormones for rooting of cuttings may therefore be of practical importance. Of course, since the hormone is produced in leaves and buds their presence will, in general, facilitate rooting also.

If these compounds are applied in rather high concentrations to a decapitated plant they produce a marked swelling which may comprise both enlarged cells and also new cells formed by rapid division, especially of the cambium. In 1933 Snow showed that the activation of cambium, which Jost found long ago to be due to the influence of leaves and buds, is due to a hormone which can pass across a discontinuity. Subsequently he found (1935) that auxins A and B and indole-3-acetic acid stimulate the cambium, and that the action is exerted at about the same concentrations of growth substance as normally exist in the plant. The postulated "cambial hormone" is thus the same as the other hormones.

Another aspect of these multifarious activities was brought to light earlier by Thimann and Skoog (1933, 1934) and was in fact the first proof that these substances have more than one function in the plant. It had been made very probable by Snow in 1925 that the inhibition of the development of lateral buds in a herbaceous plant by the terminal bud is due to some inhibiting substance which can diffuse across a dead stretch of stem. In our experiments it was found that in *Vicia faba* the terminal bud produces large quantities of growth substance, while young undeveloped buds, which do not inhibit other buds, produce practically no growth substance. It was therefore suspected that the postulated "inhibiting substance" was identical with the growth substances. This was proven by applying the growth-promoting substance obtained from mould cultures (since proven to be indole-acetic acid) to decapitated plants, in concentrations comparable to, or somewhat higher than, those obtaining in the plant. The buds were completely inhibited in their development (see Fig. 6).

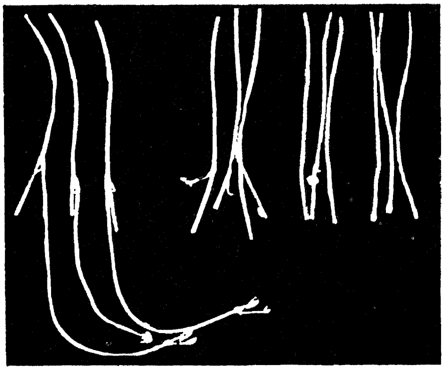


Fig. 6.

Bud inhibition on etiolated pea seedlings after decapitation. Left to right; 2·5, 0·6, 0·15 mg. Indole-acetic acid per gram of lanolin, and untreated controls respectively. Note also the marked swelling produced by the highest concentration. Growth of main stem is about the same in all four groups.

Later work showed that here again auxin A and B and indole-3-acetic acid were all highly active. It may be mentioned here that Nielsen found that roots are also inhibited in their growth by auxin preparations; subsequently all three of the above substances have been found to have this effect. Root inhibition may even be used to

some extent as a test for auxins. Thus the initiation of roots is stimulated, but their growth retarded, by the substances.

All this work shows that the same compounds are responsible for a large number of activities in higher plants, involving cell extension, cell division, and processes of differentiation and inhibition. Are all these phenomena due to the same primary process? *A priori*, it seems unlikely that one cause could start so many processes. Nevertheless, the evidence indicates that it is so. The writer has shown that those other substances IV and V, which partially imitate the action of the auxins I, II and III, also cause initiation of roots, inhibition of root growth and inhibition of bud development. They are limited in their action by being poorly transported, but the activity is there. Other substances are under study. Thus it is probable that any compound which brings about one of these effects has the power to bring about all of them, provided only that it is not prevented from doing so by failure to be transported, or by other limiting factors, such as water for cell extension or sugar for root formation. Thus we reach the view-point that the auxins and the other related active compounds (all of them unsaturated organic acids or easily hydrolyzable esters) exert some kind of general stimulation on the cell. The subsequent observed response depends on the condition, nature and anatomical position of the cell. The cells in young tissues may increase in size; older cells may not do this, but some of them respond by division, those in the parenchyma between bundles giving rise to cambium, those in the pericycle giving rise to root initials. The inhibition of bud development and of root growth, however, are not explained by this or any other satisfactory view at present. The rôle of other factors together with the above hormones may prove of great importance.

In conclusion it may be said that not only has knowledge of hormones thrown much light on some aspects of plant physiology, but it has also given us a new set of tools for the study of genetics, morphology and problems of development.

References to literature will be found in the recent documented reviews of Snow,[1] F. A. F. C. Went,[2] F. W. Went,[3] Jost[4] and Thimann.[5]

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1 *New Phytologist*, 1932, **31**, 336.
2 *Biol. Rev.*, 1935, **10**.
3 *Botan. Rev.*, 1935, **1**, 162.
4 *Zeit. f. Botanik*, 1935, **28**, 260.
5 *Ann. Rev. of Biochem.*, 1935, **4**, 545.

Animal Husbandry in India—Retrospect and Prospect.

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Imperial Institute of Veterinary Research, Muktesar–Kumaun, U.P.

ANIMAL Husbandry may be defined as the art of producing, maintaining and disposing of the different species of domestic animals and poultry in the best possible manner for those uses which man requires of them, and, in the same way as the scientific method is now considered essential for progress in most other walks of life, so in this subject it is necessary to remember that any contemplated development should be based on the three sciences of veterinary medicine, animal nutrition and animal genetics. The analogy of Animal Husbandry amongst the livestock population to Public Health amongst the human population will thus be seen.

As Indian Agriculture is so dependent on its cattle throughout its activities, there has been a tendency to think only of these animals when talking of Animal Husbandry and to look upon this art as being connected only with the processes of crop and milk production, but, as will be seen from the definition above and from what follows, Animal Husbandry work covers a much wider field. For this reason it is suggested that India could not do better than follow the lead of other progressive agricultural countries, which make a point of using the word "Agriculture" in its widest sense in official correspondence, and adopt the terms Plant Industry and Animal Industry to describe the two great divisions into which the subject can be divided.

To ascertain the value of India's major livestock industries a survey was carried out by Colonel Olver, Animal Husbandry Expert, and Rao Bahadur Vaidyanathan, Statistician to the Imperial Council of Agricultural Research, and we are now able to allot them an approximate figure. It will probably surprise many to learn that this figure,

even at a very conservative estimate, slightly exceeds the value of her cash crops. The original estimations were based on prices ruling in September 1929, and assuming that there has been a drop in prices of 33% since that date, we arrive at the following figures for the different items which go to make up the enormous total :—

	Crores of rupees
1. Milk and milk products ..	540
2. Cattle labour in agriculture ..	408
3. Manures	180
4. Labour for purposes other than agriculture	107
5. Other products such as hides and skins, meat, wool, etc.	30
6. Live animals exported ..	0·12
	1,265·12

It will be seen that such items as the inland trade in livestock and profits from horse, poultry and pig breeding and other minor industries, have been excluded from the calculations, owing to the difficulty of obtaining even approximate figures of their value at the present time, but there is no doubt whatever that if they were included the total would exceed Rs. 1,300 crores *per annum*, a sum sufficiently large to justify the plea that is being made for the exploitation of this industry on more scientific lines.

The Government of India early recognised that the welfare of India's livestock largely depends on the control of contagious disease and set up as long ago as 1890 what is now the Imperial Institute of Veterinary Research, Muktesar, for the investigation of these ailments and the preparation of agents for their control. That it has more than justified the money that has been spent on it cannot be refuted, for a number of those conditions with which it was originally charged to deal, notably Rinderpest in cattle and Surra in horses, are now well under control, provided that the requisite amount of field staff can be made available. The cause of a large number of other conditions has also been elucidated, and in this connection it is noteworthy that the Royal Commission on Agriculture in 1927 observed that scientific research into these matters appeared to be progressing at a quicker rate than executive staffs were able to take advantage of it, and the position has not improved greatly in this respect since that report was written. One realizes that the provision of more fully trained veterinary field staff by the Provinces and States is a matter of considerable difficulty in these days of restricted revenues, and the only solution appears to be the training of a cheaper agency. In other countries stockmen are employed in Animal Husbandry departments to carry out the duties of vaccinator, castrator, etc., under veterinary supervision. It is particularly desirable that protection on a large scale should be made available for the control of Rinderpest, by far the most destructive cattle plague in India, for in the recently adapted goat virus, which can be used alone as a vaccine on all country cattle and even on cross-bred calves up to the age of 18 months, we have a simple, efficient and cheap product, which should prove a most powerful weapon, if properly used, not only for the control of the disease, but also for the automatic improvement of cattle by using it to save the valuable animals, when time and money will not permit of its application to the worthless ones.

Next in importance in Animal Husbandry work to the control of contagious disease is the question of Animal Nutrition, and we have had small sections working for some years on this subject at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and the Agricultural Colleges at Coimbatore and Lyallpur. More recently, a small staff has been financed by the Imperial Council of Agricultural Research and attached to the Agricultural Chemist's Laboratory at Dacca, so that local investigations are now being carried on in several typical parts of the country. These include the analysis with digestibility trials of a number of grains and fodders in common use in India, and it is important that this work should be continued. In addition, more fundamental work connected with the maintenance of animals in India in the optimum state of health requisite for the duties they have to perform, whether this be work, production of milk, wool or other articles of trade, and to increase their resistance to disease, is required and as a result of a grant from Government facilities for this will be provided at the new Animal Nutrition Section which is being added to the central organisation for Veterinary and Animal Husbandry Research at Izatnagar, a sub-station of Muktesar.

Undoubtedly the outstanding scientific

problem in India to-day is one of nutrition and it is one for the solution of which the best brains amongst workers in crop production, human nutrition and animal nutrition will be required. India's human population is increasing by leaps and bounds, her animal population is much larger than it should be, and in both cases there is already a vast amount of mal-nutrition prevailing. The ideal state would be for the plant breeder to show the ryot how he can produce larger and better crops for his own consumption, so releasing some of the land for the production of fodder crops for his animals, which in turn should produce more milk and other products for his household or for sale, and better manure for his land. It will be a very long time, however, before such an ideal is attained in India and in the meantime animal husbandmen must endeavour to alleviate the situation in other ways. The most promising line appears to be the better utilisation of forest grazing areas for the rearing of young stock, and this, of course, is a matter which cannot be dealt with satisfactorily without the co-operation of the Forest Department, but given this and the closest possible cohesion between Livestock and Veterinary officers, it should be possible to arrange for these areas to be more effectively used and for them to rear better cattle, which should find their way to those parts of India which are unable to provide the fodder necessary for young growing cattle.

The Governments of India, both central and provincial, and their advisers took action many years ago to remedy some of the most obvious causes of the degeneration of cattle in India by establishing cattle farms for the production of breeding bulls of known pedigree and in some cases to preserve a breed from extinction. Some of the best examples of these are the Hissar farm in the Punjab for the Hariana breed, the Chharodi farm in Gujerat for the Kankrej breed and until lately the Madras Government maintained the Chintaladevi farm for the Ongole breed, the animals of which are in great demand for export to other tropical countries. Unfortunately, during the recent financial depression, this latter farm was closed as a measure of retrenchment.

The Central Government in this matter have devoted themselves mainly to the question of maintaining and improving some of the best milch breeds in India, and the Sahiwal herd at Pusa, the Scindi herd of the Imperial Dairy Institute at Bangalore and the Tharparkar herd at the Imperial Cattle Breeding farm at Karnal will ever remain a testimony to their foresight.

It cannot be expected, however, that the different Governments will always be prepared to undertake the whole of the work that is necessary for the maintenance of pedigree herds of India's many breeds of cattle, to which buyers both from inside and outside the country can go for their requirements, and it is to be hoped that more land-owners will follow the good example of the Pattakar of Palayakottai, who keeps a pedigree herd of Kangayam cattle near Coimbatore in the Madras Presidency, and maintain similar herds of the breed indigenous to the tract in which they live. These should, if required, prove a source of profit to the owner, and they can be used for the production and distribution of breeding bulls to the surrounding villages.

When all is said and done about cattle farms, however, we are still faced with the position that they can do only a small part to help in the general improvement of the cattle of this great sub-continent, for which more intensive work in the villages by those qualified to give advice is the only solution. The most important items are the introduction of controlled breeding with specially selected or herd-book sires, in the manner recently initiated in the Punjab and the Bombay Presidency, the castration of all unsuitable males, and propaganda work on the general feeding and care of animals, particularly the young.

In addition, India should now consider the desirability of following the example of other progressive agricultural countries which have set up organisations for the study of applied animal genetics, where investigations can be carried out into such subjects as the inheritance of milking and working qualities, wool and egg production, disease resistance factors, etc., technical breeding processes like artificial insemination, and sterility, particularly the partial sterility from which so many Indian cows suffer and which has to be removed before the cattle population can be reduced to figures more commensurate with the available food supply.

There still remain the side-lines of Animal Husbandry such as commercial dairying, poultry keeping, sheep and goat breeding, horse-breeding and the cottage industries of silkworm-rearing and bee-keeping, which

to-day are usually included under this head. Of these, the Dairy industry is by far the most important to India, even judged by figures alone, but apart from this is the fact that milk and its products will supply the animal protein and fat which are so necessary for the proper nutrition of a human race whose diet is predominantly vegetarian. It is a matter for gratification, therefore, that at the instigation of the Imperial Council of Agricultural Research, the Government of India have recently allotted a sum of Rs. 6 lakhs, which is to be devoted to improvements to the Imperial Institute of Dairying at Bangalore and the re-opening of the Anand Research Creamery, which will be staffed and equipped with the primary object of devising the best methods for the collection, preservation and transportation of village milk to the big cities of India. This work, if successful, should at one and the same time improve the lot of the villager, provide the town dweller with more of the food he requires at cheaper rates, and save from slaughter many specimens of India's best milch breeds, which to-day are brought into the cities in large numbers and destroyed after one lactation.

In order to help the Poultry industry, it has also recently been decided by Government to add a Poultry Research Section to Izatnagar, where investigation into Poultry diseases and different industrial processes will be undertaken side by side.

This new movement for the better development of Animal Husbandry in India has been set in motion chiefly through the efforts of the Imperial Council of Agricultural Research and should act as a great stimulus to workers in veterinary, dairy and their ancillary sciences. Very little work connected with domestic animals has been undertaken at the Indian Universities up to the present, but they are admirably suited for the investigation of some zoological subjects, such as the identification and life-history of ecto- and endo-parasites, certain physiological problems, the analysis of local fodders and grasses, etc. It is to the Veterinary profession in India, however, that the prospect should make the greatest appeal and it is to be hoped that its members, and particularly those responsible for devising the curriculum for the Veterinary graduates of the future, will see that the profession is fit to take its proper place in this new campaign.

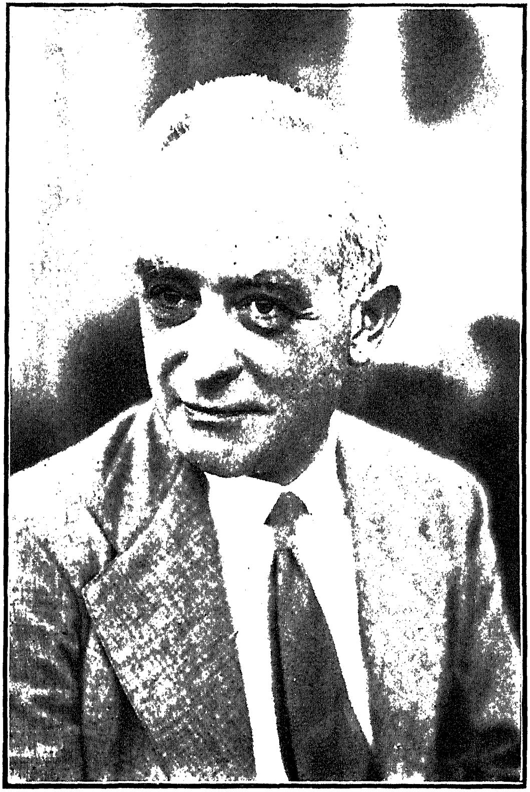
So far the main object of Veterinary courses in India has been to teach the control of disease, but the endeavour of Veterinary Colleges in all other parts of the world to-day is to turn out, not merely a man well-versed in that subject, but one who also understands animals at all stages of their existence and is able to get the best out of them, *i.e.*, the complete animal husbandman. When the Royal Commission on Agriculture was discussing the best type of officer to employ on cattle breeding farms it remarked that "when the knowledge and instincts of the farmer and cattle breeder are combined with the professional training of the Veterinary Surgeon the position is ideal".

Another great authority, Sir Daniel Hall, late Scientific Adviser to the Ministry of Agriculture in England, in a recent lecture stated "I see the task of the people who are dealing with the health side of animals to be, in future, very much more hygienic and the maintenance of health than the cure of disease. What I would like to see is a class of Veterinarians who are officers of animal health rather than practitioners. There must always be practitioners who are concerned with surgical cases and with specific illnesses of valuable animals, but it seems to me that the great efforts of the profession should be rather of a public nature. Instead of being called in to this ailing cow, or that fretting horse, we want to see a class of men who have charge of a district, who are thinking about the horses, the cattle, the sheep and the pigs and how to keep disease away from them. Naturally, they will have to know about the endemic diseases, but breeding, environment, nutrition, and other factors in hygiene will be equally important. I think that is going to be the direction in which the Veterinary profession itself will eventually move, and that the veterinarian of the future will be the kind of public officer who is taking prophylactic and preventive measures and who is studying problems like nutrition and so forth, so as to ensure a greater amount of health amongst the animal population."

If the teachings of these authorities are followed, then there should be evolved a class of livestock officer for service in India who is able to take full advantage of the encouragement and help now being given by Government and we may look forward to a great future for Animal Husbandry in India.

Prof. Max Born.

PROF. BORN arrived in Bangalore on the 24th September 1935 and left it again to Cambridge on 18th March 1936, having been in residence at the Indian Institute of Science for a period of six months. His main work during this rather short period was the delivering of a course of lectures on optics. This general course, which was attended by the students and members of staff of the Physics and Mathematics Departments of the Institute and the Central College, consisted of nearly 25 to 30 lectures on molecular optics, on the quantum theory of radiation and on the recent neutrino theory of light. In addition to these general lectures, a set of about a dozen lectures were delivered to a special batch of students on the new field theory. Prof. Born also took constant part in the usual weekly Monday seminars at the Institute and was a source of inspiration to workers in different branches of experimental and theoretical work. During this short period, Prof. Born also delivered about half a dozen public lectures where he showed that he was a great master in the art of making the results of abstruse scientific thought popular to the lay public. Prof. Born also had, working under him, students dealing with problems on the Kristalgitter theorie, neutrino theory of light, unitary theory of field and matter and optical activity.



Prof. Max Born.

It is amazing to speculate how profoundly a great scientific mind can influence those coming in contact with it. A most eminent physicist alike in the depth of physical insight and the breadth of mathematical power, a most lovable personality with a fine sense of humour and a teacher whose encouragement and kindness to his students is perhaps unparallelled — these are some of the traits that strike any one who has come into constant contact with Prof. Born. The one thought uppermost in the minds of his students and admirers is that it might be possible for him to come again to Bangalore and stay for a longer period.

B. S. M.

A Preliminary Survey of Marine Boring Organisms in Cochin Harbour.

By Eileen Whitehead Erlanson, Ph.D., D.Sc.

MARINE boring organisms destructive to shipping, particularly the Shipworms (Teredinidæ), have been mentioned by writers from early times. The first careful scientific study was made in the eighteenth century when timber in the dykes of Holland was badly attacked by shipworms, and a detailed treatise on their anatomy and habits was published by Godfrey Sellius[1] in 1733. Since then several accounts of these specialised molluscs have appeared and a multitude of species have been described differing in minor morphological characteristics. No modern biological survey was undertaken in any region until the wooden piers and jetties in San Francisco Harbour were invaded by shipworms and collapsed twenty years ago. The resulting report by Atwood and Johnson[2] which was sponsored by the National Research Council describes methods of attack which were followed in this present study. After the World War the Institute of Civil Engineers, London, also initiated a survey of marine borers, with Dr. W. T. Calman as technical adviser.[3] Specimens were sent in by members from all over the world, but these were mostly pieces of damaged wood. The British Museum has also published a very helpful bulletin by Dr. Calman.[4]

Late in 1934 it was discovered that there was only one specimen of molluscan borers in the British Museum from India. Crustacean Isopod borers from the East were also not well represented in London nor in Museums in India. With the exception of the shipworms the taxonomy of marine boring organisms has received scant attention in spite of the economic interest. It is with a view to stimulating the interest of Indian scientists in these fascinating creatures that this report is published. I am indebted to C. W. Knight, Esq., for help with the Survey, and to Dr. I. Gordon of the British Museum for identification of the Crustaceans. She could only give tentative specific names and states that Indian material should be studied further and that the Cochin specimens differ somewhat from type descriptions.

COCHIN HARBOUR.

The opportunity was taken in 1935 to make an initial survey of the marine borers in the waters in and about Cochin Harbour, Malabar Coast, South India. This is a fine natural harbour, cut off from the Arabian Sea on the west by long low sandy spits between which there is a single narrow gut some 1,500 feet wide. To the north and south the harbour is continuous with hundreds of miles of shallow brackish lagoons called Backwaters which stretch into South Malabar, Cochin State and Travancore, and receive the waters of several large rivers from the Western Ghats.

Cochin Harbour lies at about 10° North and receives the full benefit of the south-west monsoon, as well as some precipitation from the north-east monsoon from October to December. The annual rainfall is 120 inches, more than half of which falls in the four months from June to September. During and right after the south-west monsoon the water in the backwaters, and even on the Cochin shore of the harbour, some two miles from the entrance, is not salty to the taste, soap lathers easily in it and it is used by the villagers for cooking.

This study was made in the sixth month commencing with the end of April 1935. It was started just before the monsoon. Unfortunately no data were obtained on the salinity of the water in the different stations. The following information was kindly supplied by the Harbour Engineers to the Madras Government.

On 21st August 1922 the salinity of the water at the centre of the harbour gut, about 2½ hours after the inflow of the tide commenced, was 1·029 specific gravity reading.

ORGANIC GROWTH ON STEEL CRAFT.

At Seattle, Washington, U. S. A., there is a series of lakes connected with the sea. These lakes have been separated by lochs,

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[1] Sellius, Godofredus, 'Historia naturalis teredinus, seu, Xylophagi marini....' *4to Trajecti ad Rhenum*, 1732.

[2] Atwood, W. G., and Johnson, A. A., "Marine Structures, their deterioration and preservation," *Rept. of Ctte. on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council*, Washington, 1924.

[3] Redgrove, G. R., Calman, W. T. and others. *1st Report of Cttee. on the deterioration of structures of timber, metal and concrete exposed to the action of sea-water.* Inst. of Civil Engineers, London, 1920.

[4] Calman, W. T., *Brit. Mus. (Nat. Hist.), Economic Series*, 1919, No. 10.

and ocean-going freighter ships are able to free their hulls of the accumulated growth which they collect by anchoring in the eastern lake where the water is fresh, the organisms die and fall off in a few days. A similar procedure is not possible in Cochin harbour because the channels are very shallow, except where they have been dredged just inside the harbour mouth. Steel barges which carry oils to Quilon, over one hundred miles to the south, and to Kottayam about 45 miles to the south, must go into dry dock every three or four months to have barnacles and oysters removed. These animals attach themselves all over the keels from about six inches below the water line. They are able to penetrate the so-called anti-fouling paint and then start oxidation in the steel plates finally causing small corroded pits.

There are no boring organisms which attack steel.

Balanus sp., the common barnacle grows slowly in Cochin harbour and vicinity and dead cases of half-grown individuals are often present. The low salinity is probably responsible for this. Nevertheless there is always an abundant supply of young animals on immersed surfaces, and there must be strains of barnacles and oysters here which are adapted to a low salinity.

ORGANISMS BORING INTO SUBMERGED WOOD.

Most of the transportation in the back-waters is done in wooden vessels called vallams. They are usually made of Venteak or Marudu wood boards sewn together with coir (cocoanut fibre) cords. It is necessary to bring these boats into dry dock about twice a year to renew planks which have become weakened by molluscan borers.

Boards which appear sound from the outside may be riddled and honeycombed with burrows within, because the molluscan borers enter the wood as microscopic larvæ. The shipworms remain in their original burrows until death and retain the first entrance point for breathing purposes. When infected wood is immersed the two short siphons of each shipworm can be seen protruding from these small holes, which are only 1–3 mm. in diameter. As soon as the wood is not submerged the siphons are withdrawn and the entrance to the burrow is closed by a ring of tissue on the siphons and by two tiny shelly scales, the pallets. The Teredinidæ are differentiated taxonomically chiefly by the morphology of these pallets. When the wood they inhabit is withdrawn from the water the molluscs keep their burrows closed and full of salt water. Thus they are able to survive for even fourteen days.[3] Bhum[5] found that *Teredo navalis* L. was able to survive in a low lethal salinity so long that after thirty-three days 10% of the animals were still alive.

Table I shows the borers which were found in seven pieces of wood from different places around Cochin harbour in April and May 1935. Two genera of the Teredinidæ were present. Teredo with simple pallets, and Bankia (syn. *Xylotria*) with compound pallets. No large individuals of Teredo were found, and this genus is evidently more intolerant than Bankia of brackish water, although Miller[10] found the opposite to be true in California; Calman[4] states that Teredo will not flourish in brackish water. Molluscan borers belonging to the family Pholadidæ are very abundant in the Cochin waters, they were present in every wood specimen. These have been identified as *Martesia striata* L., by G. I. Crawford, Esq., London. This borer has a cosmopolitan range and is abundant everywhere in the tropics (Miller, 9, plate 8). Although Martesia were obtained three miles out to sea, they were also abundant in logs lying in only slightly brackish water in the Tatapuram boat basin (see Table I). The Pholadidæ have short bodies which are completely invested in the scabrous shells. The shells of young Martesia resemble those of young Teredo, but there are no pallets. There is a pair of small accessory plates between the valves of the shell on the dorsal surface, and also a larger ventral plate in Martesia. These borers are drop shaped and fit closely into their burrows, where they form plugs just under the surface of the wood until they die. In the adults a shelly dome continuous with the valves covers the foot and prevents further boring. The largest Martesia were $1\frac{1}{2}''$ long and about $\frac{3}{4}''$ thick near the base.

The absence of Teredinidæ in the old cocoanut-piles from the Standard Oil Company's Jetty may be attributed to the turbid shallow water there. Shipworms cannot thrive in turbid or sewage polluted water,[3] but such conditions do not deter Martesia.

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[5] Bhum, H. F., *Univ. of Calif. Publ., Zoo.*, 1922, **22**, Pt. 4, p. 349.

TABLE I.

Boring organisms found in submerged wood, Cochin Harbour, April 1935.

Type of wood, location and time immersed.	Teredinidæ.	Pholadidæ.	Crustacean Isopoda and other borers.
Poon wood. Dolphins beside dry dock, Willingdon Island. 10 yrs. Copper sheathed.	*Bankia setacea*, 2; 19″ and 21″ long, also empty burrows.	*Martesia striata*, 1 adult.	*Sphæroma terebrans* and *S. Annandalei*, very numerous.
Marudu plank. Jetty, N. E. Willingdon Isl. 2 yrs.	Burrows, 1 large, several small, empty. *Teredo diegensis* Bartsch, 1, young, ½″ long.	None.	*Sphæroma terebrans*, very numerous, burrows to ¾″ deep. Polychæta, 1.
Teak. Edge of pile, Vypeen reclamation. 2 yrs.	None.	*Martesia* adults, heavy infection.	*Sphæroma terebrans*, several.
Teak. Channel buoy, 3 mls. out. 6 months.	,,	*Martesia striata*, several young and adults.	None.
Marudu. Plank from vallam. 6 months.	Few empty burrows 6″-10″ long.	*Martesia striata* L., heavy infection, adults.	Polychætæ, 2 large adults.
Cocoanut wood pile, Standard Oil Co. Jetty, 2½ mls. N. E. of harbour. 5 yrs.	None.	*Martesia striata*, many adults.	None.
Eriodendron log. Boat basin, Tatapuram, 2 mls. N. E. of harbour. 4 months.	,,	*Martesia striata*, heavy infection with half-grown animals.	,,

There is also a Crustacean Isopod borer which causes a great deal of damage, particularly to docks and piers in Cochin, and which belongs to the widely distributed genus Sphæroma.[4] Sphæroma is common in the tropics and in the southern hemisphere and is a relative of the smaller Limnoria or "Gribble" of northern waters. Specimens from Cochin have been identified as *S. terebrans* Bate, and as *S. annandalei* Stebbing.[6] These Crustaceans do not usually attack floating timber. Unlike Limnoria, Sphæroma can thrive in almost fresh water.[3,7] They are very destructive and often form colonies where the burrows are twelve to sixteen to the square inch. The burrows are visible from the surface, and are from ¼″ to 1″ in depth and up to 1/5″ in diameter with straight sides. Adults swim about and can leave their burrows at any time and attach themselves to a fresh piece of wood. They begin to bore in any cranny or flaw, and were often found in empty barnacle shells. At mating time a male shares a burrow with a larger female. Females were seen in August with brood pouches full of young, and they probably breed throughout the year.

TRAPS FOR MARINE BORERS.

Traps were constructed as directed by Atwood and Johnson.[2] Each consisted of seven blocks of wood, 10 × 4 × 2½ inches, attached to an upright post. These were immersed at three stations :—(1) Traps I and II off the north-east shore of Willingdon Island Reclamation in the centre of the harbour; (2) Traps III and IV off British Cochin near the harbour entrance where the water was saltiest; (3) Traps V and VI at the mouth of the Government Canal, two miles north-east of the harbour entrance at the Burmah Shell Company's jetty. At stations 1 and 2 two traps were set, one of hard Marudu wood and one of softer Venteak. At station 3, both traps were of Marudu, one untreated, the blocks of the

[6] Stebbing, T. R. R., *Rec. Ind. Mus.*, 1911, **6**, Pt. 4, 81–182.

[7] Miller, R. C., *Ecology*, 1926, **7**, No. 3, 247–254.

second had been soaked in an oil preservative. Growth was found to be so slow that it was unprofitable to examine the blocks more often than once in two months. The data from these examinations are shown in Table II, for Traps I to IV. After seven months, three remaining blocks from each trap were shipped to Madras, where I examined them. They had been *en route* for five days, yet all organisms were still alive.

On all traps, blocks number 4 were about half way between high and low tides, ordinary spring tides; blocks 1–5 were always exposed at low tide, and blocks 6 and 7 only at spring tides; blocks number 1 were barely covered at high tides.

An indication of the quantity and quality of the surface growth on the blocks is given in Table II, column 2. It has been observed that this growth accumulates far more rapidly in traps laid down off Madras in the Bay of Bengal than in Cochin Harbour. Professor R. Gopala Aiyar agrees that the low salinity in Cochin is probably responsible for the slow growth there.

EFFICIENCY OF OILS IN PRESERVING MARINE STRUCTURES.

Fish oil and bitumen are used locally in Cochin to protect wooden craft against marine borers. Two traps of Marudu wood blocks were set in the water at the Burmah Shell Jetty on June 1, 1935; one was of untreated wood, the blocks of the other had been soaked in a mixture of one part fish oil and one part bitumen. The water at this station is almost fresh after the monsoon, and is turbid with silt and sewage. After two months, on August 1, blocks number 4 were removed. There was a sparse surface growth of barnacles and algæ (*Chætomorpha linum* Fl. Dan.; *Caloglossa leprieuru* (Mont.) J. Ag.; *Microcoleus cthonoplastes* Thuret.*) but no borers were seen. After three months, in September, blocks number 5 were examined. The surfaces were covered in fine silt and there was scarcely any organic growth. No borers were found in the untreated block. The treated block contained several small burrows of *Martesia striata* 1/16 inch in diameter, on all surfaces, a few of which were dead. A few *Sphæroma terebrans* had also started to burrow in flaws and cracks in the wood. In October, after four months immersion, blocks number 6 were examined. The untreated block contained several scattered young Martesia burrows on all surfaces. The treated block also contained Martesia, but fewer than the untreated block. A few Sphæroma had burrows to ⅛″ deep in the treated wood. While dissecting the blocks it was obvious that the oil treatment had softened the wood, thus facilitating penetration.

PERIODICITY AND GROWTH OF MARINE BORERS.

1. *Sphæroma terebrans* and *S. annandalei* were always active. They attacked blocks from 8″ below to 2½′ above low water ordinary spring tides.

2. *Martesia striata* larvæ were present from April to October. They attacked blocks from 6″ to 2′ above low water ordinary spring tides. They attacked softer wood more readily than harder, but not until the blocks had been immersed over two months.

3. *Teredo* spp. larvæ were present from May to September. They attacked blocks 1″ below and 9″ above low water ordinary spring tides. They also attack softer wood first and grow twice as fast in Venteak as in Marudu. No infections were found until wood had been immersed for more than two months. Growth was very slow, burrows were only four inches long in Venteak after five months immersion. Miller[8] reports a similar growth rate for Bankia in California, but much faster rate of growth has been reported by others for the coasts of North America and elsewhere.[4,9] Again the low salinity after the monsoon is no doubt responsible. A variety of pallets of Teredo were found, and these have been tentatively identified according to the key of Hill and Kofoid[11] and Miller's figures[10] as belonging to four species; *T. diegensis* Bartsch, *T. furcillatus* Miller, *T. navalis* L.

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* I am obliged to Prof. M. O. Parthasarathy Iyengar for these identifications.

[8] Miller, R. C., *Uni. of Wash. Publ. in Oceanography*, 1935, **2**, No. I, pp. 1–18.

[9] White, F. D., *Contrib. to Canadian, Biol. and Fisheries, N. S.*, 1929, **4**, 1–25.

[10] Miller, R. C., *Univ. of Calif. Publ. in Zoo.*, 1924, **26**, No 7, 145–158.

[11] Hill, C. L. and Kofoid, C. A., *Final Report of San Francisco Bay Marine Piling Cttee.*, Univ. Calif. Press, 1927 (Key to *Teredinidæ* by Bartsch).

TABLE II.

Growth found periodically in wood blocks of traps set in Cochin Harbour.

TRAP I. VENTEAK, AT EXECUTIVE ENGINEER'S JETTY, NORTH-EAST END OF WILLINGDON ISLAND. IMMERSED 24TH APRIL 1935.

Block examined, date and time immersed.	Surface growth.	Borers present.
*4, 22nd May. 1 month (renewed)	Barnacles—sparse. Green alga, *Chætomorpha*. Crustacean larvæ.	None found.
*4, 20th July. 2 months (renewed).	Alga—*Rhizoctonia*, sparse. Thick growth of small barnacles, and Diatoms. Crustacea and Polychætæ.	,,
*5, 20th July. 3 months.	Barnacles less than *4. Algæ: *Rhizoctonia* and *Caloglossa*. Larvæ.	*Martesia* on top, scattered holes to $\frac{1}{8}''$ diameter, some dead. Larvæ of boring molluscs. *Sphæroma*, few in empty barnacle cases, no burrows.
*4, 6th September. 7 weeks.	Barnacles over 50% of surface. Mat of green algæ, diatoms, sponges. Protista, Molluscan larvæ, nemas and crustacean larvæ.	*Sphæroma*—1 colony in crack in wood, also Polychæte worm.
*3, 6th September. $4\frac{1}{2}$ months.	Barnacles, heavy incrustation. Green algæ and small sponges, diatoms, etc. as *4.	*Sphæroma*, few half-grown animals in burrows on the base of block.
*6, 24th September. 5 months.	Barnacles scattered all over to $\frac{1}{2}''$ diameter, some empty. Green algæ, sparse, *Chætomorpha*; some blue green *Microcoleus*. Protista, sponges, Crustacean larvæ and young.	*Sphæroma*, numerous scattered burrows to $\frac{1}{4}''$ deep, in face ends and top of block. *Martesia*, few in face, $\frac{1}{4}$–$\frac{1}{3}''$ high. *Teredo*, numerous burrows in top and front in $\frac{3}{4}''$ saturated wood. Pallets variable. *T. diegensis* and *T. navalis*. Burrows 2-4" long.
*1, 2 and 7, 30th November. 7 months.	Barnacles over all surfaces, some *Mitellus*, and Alga—*Chætomorpha*.	*Sphæroma*, few small burrows in each block.
TRAP II. MARUDU WOOD. WITH TRAP I. IMMERSED 24TH APRIL 1935.		
*4, 22nd May. 1 month (renewed).	As Trap I.	None found. Larva of boring Mollusc.
*4, 20th July. 2 months (renewed).	,,	None found.
*5, 20th July. 3 months.	,,	*Sphæroma*, few in empty barnacles. *Martesia*, few holes to $\frac{1}{8}''$ diameter, all dead, orifices 1/16". Less infection than in Venteak.
*4, 6th September. 7 weeks.	,,	None found.
*3, 6th September. $4\frac{1}{2}$ months.	,,	,,
*6, 24th September. 5 months.	,,	*Sphæroma*, *Martesia* and *Teredo*, all less than in Trap I. *Teredos* $\frac{1}{2}$–1" long, several dead. Few *Martesia* $\frac{1}{4}''$ high, mostly dead.
*1, 2 and 7, 30th November. 7 months.	,,	*Sphæroma*, few burrows in Bl. 2, no borers in *1 and 7.

TRAP III. VENTEAK, AT PORT TRUST JETTY, NEAR HARBOUR ENTRANCE, COCHIN. IMMERSED 26TH APRIL 1935.

Block examined, date, and time immersed.	Surface growth.	Borers present.
*4, 22nd May, 1 month (renewed).	Barnacles, small, covering whole surface. Also many colonial hydroids, diatoms, nemas, protista, crustacean larvæ.	*Sphæroma*—2 small ones in empty barnacle case.
*4, 27th July. 2 months (renewed).	Barnacles covering whole surface; green algæ *Chætomorpha*, diatoms and crustacean larvæ.	None found.
*5, 27th July. 3 months.	Thick surface coating of barnacles, *Mitellus*, sponges, larval cases, few green algæ, with Crustacea and Planaria.	*Teredo*, several small burrows $\frac{1}{4}$–$\frac{1}{8}$″ long in base. *T. furcillatus* Miller. *T. navalis* L. and *T. samœnsis* Miller.
*4, 6th September. 6 weeks.	Covered in silt, very little growth. Few barnacles and green algæ, *Chætomorpha*.	*Sphæroma*, 3 small, in crack in block.
*3, 6th September. 4½ months.	Heavy growth of Barnacles and *Mitellus*; green and red algæ and silt. Crustacea and worms.	*Sphæroma*, 6 small, starting to burrow underneath. *Martesia*, 3 tiny specimens, burrows 1/16″ long. 1 dead.
*6, 25th September. 5 months.	Heavy, thick encrustation as *3, 6th September.	*Sphæroma*, few small in burrows.
*1, 2 and 7, 30th November. 7 months.	Barnacles over whole surface. Some algæ, *Chætomorpha* and *Caloglossa*.	*Sphæroma*, few burrows in 1/5″ deep in each block.
TRAP IV. MARUDU WOOD. WITH TRAP III. IMMERSED 26TH APRIL 1935.		
*4, 22nd May. 1 month (renewed).	As Trap III.	None found.
*4, 27th July. 2 months. (renewed).	,,	,,
*5, 27th July. 3 months.	,,	*Teredo*—few short burrows at ends $\frac{1}{8}$–$\frac{1}{4}$″ long. *T. navalis* L. *Sphæroma*, 1, in short burrow.
*4, 6th September. 6 weeks.	,,	None found.
*3, 6th September. 4½ months.	,,	*Sphæroma*, 5, in short burrows.
*6, 25th September. 5 months.	,,	None found.
*1, 2 and 7. 30th November. 7 months.	,,	*Sphæroma*, few burrows in Bl. 7, none in *1 and 2.

and *T. samœnsis* Miller. Professor R. C. Miller and other specialists have informed me that the taxonomy of this genus is still in a state of flux.

(4) *Bankia setacea* was not found in the traps. White[9] found specimens ½″ long with typical pallets in wood after less than two months immersion in Departure Bay, British Columbia. He reports that in less than three months blocks of Douglas fir were so riddled with shipworms, that they could be broken by hand.

PROTECTION OF MARINE STRUCTURES AND WOODEN CRAFT.

Contrary to local opinion the activity of molluscan borers in Cochin harbour and vicinity is less than elsewhere. Wooden craft could certainly be protected indefinitely if they were taken into dry dock every two to three months, when the borers are tiny and close to the surface, and the keels scrubbed with a cheap poisonous wash, such as copper sulphate, mercuric bichloride, hot brine or lye solutions.

Fish oil and bitumen do not act as deterrents. They soften hard wood and seem to be attractive to Martesia.

Silt, sewage and a heavy incrustation with barnacles all tend to prevent the entrance of molluscan borers.

Sphæroma are always numerous and there seems to be not a way of protecting wooden piling except by sheathing them in copper or concrete.

SUMMARY.

Wood block traps were immersed at three stations in and near Cochin Harbour. They showed that the waters contain active larvæ of Martesia and Teredo from April to October. Owing to the low salinity growth of Teredo is very slow.

There are strains of Martesia and Balanus which can grow in almost fresh water.

According to pallet morphology four species of Teredo were found. Their attacks are limited to the region near the harbour mouth where the water is salt, and at levels at and near low water line.

Bankia setacea adults 19″ and 21″ long were found in wooden piles in the harbour, but no young appeared in the traps.

Sphæroma are always abundant and very destructive to piling.

Records of growth found in the traps for bi-monthly periods between April and November 1935 are given, also suggestions for the protection of wooden craft.

Centenaries in April 1936.

Grover (John William), 1836-1892.

JOHN WILLIAM GROVER, born on 20th April 1836, was an engineer with wide practice in several countries. He had his education first at Marlborough College and later in Germany. He was apprenticed under Sir Charles Fox and Sir John Fowler. His field of interest shifted from time to time. In the earlier years, he was engaged in Museum architecture and was associated with the building of the north and south courts of the South Kensington Museum and the erection of the conservatory of the Royal Horticultural Society. He also took a prominent part in the erection of buildings for the Exhibition of 1862. He was also associated with the erection of the Royal Albert Hall.

AS A RAILWAY ENGINEER.

In his 26th year, he set up independent practice as a Railway Engineer. His first work was the construction of 27 miles of the Manchester and Milford Railway. He surveyed various railways in Europe and prepared designs for the works of the Mexican Railway. The Kingland iron bridge, of 200 feet span over the Severn built by him, is said to present some novel features of construction. In 1873, he constructed the Mountain Railway of Venezuela. While at Venezuela he made a hydrographical survey of the coast of that country and thus prepared the way for the construction of the harbour of La Guaira.

AS A WATER-WORKS ENGINEER.

From his 37th year, he turned his attention to water-supply. He designed and constructed the water works of several towns in the Chalk districts. He was an authority on the water-supply of London. He was also employed in the survey of water-supply in Austria, Denmark, Egypt, Italy and Switzerland.

He was elected a member of the Institute of Civil Engineers in 1867 and was also a Fellow of the Society of Antiquaries and a Vice-President of the British Archæological Association.

Mr. Grover died at his residence in Clapham Common, on 23rd August, 1892.

HIS PATENTS AND PAPERS.

Of the patents taken out by Grover, the most widely known is the one for the "spring washer", used to prevent the slacking of permanent way fish bolts. These washers are being used in all parts of the world.

His chief papers are the following :—

1. "Estimates and Diagrams of Railway Bridges," 1866. 2nd edition in 1870. 2. "The Facilities of 'flexible' Rolling-Stock for economically constructing ... Railways or Tramways," 1870. 3. "Description of a Wrought-iron Pier," 1871. 4. "Iron and Timber Railway Superstructures," 1874. 5. "Suez Canals from

the most ancient times to the present," 1877. 6. "Section of a well at Hampstead," 1878. 7. "Ancient Reclamations in the English Fenlands," 1878. 8. "Chalk water-springs in the London Basin," 1887. 9. "Proposed Richmond Footbridge," 1890. 10. "An explanation of the London Water Question," 1892.

S. R. RANGANATHAN.

Tschermak (J. L. Gustav), 1836-1927.

THIS veteran mineralogist of Czechoslovakia was born on 19th April 1836. His father was a tax collector. As a school boy, he was marked by his independence and enterprise and he was the founder of a natural history society. In 1856, he went to the University of Vienna and later to Tubingen, where he graduated in 1860. He was the Director of the Hofmineralien Kabinet in Vienna from 1868 to 1877. From 1868 to 1906 he was Professor of Mineralogy and Petrography in the University of Vienna. Professor E. S. Dana of America was one of his distinguished students in 1873–74.

HIS WRITINGS.

Tschermak was a prolific writer. He has to his credit no less than 153 papers, of which only 5 were joint papers. His first paper appeared as early as 1858, in his 22nd year, in *Wien. Geol. Verhandl.* It was entitled *Trachytgebirge bei Banow.* His last paper was *Der Chemische Bestand und das Verhalten der Zeolithe.* It appeared in 1918, in his 82nd year, in the *Sitzb. Akad. Wiss., Wien.* His *Grundriss der Mineralogie* came out in 1863, while the first edition of his well known *Lehrbuch der Mineralogie* appeared in parts during 1881–1884. This book reached its ninth edition in 1923.

HIS CHIEF CONTRIBUTIONS.

While his earlier papers were of a petrographical nature, he will be remembered longest for his classic memoirs on the chemical constitution of various groups of silicate minerals. These include *Felspars* (1865), *Amphibolers* (1871), *Micas* (1877), *Zoisite-epidotes* (1880), *Scapolites* (1884), *Chlorites* (1890), *Vermiculites* (1891), *Tourmaline* (1899), and *Zeolites* (1918).

FOUNDS A PERIODICAL.

He is also well known through the important periodical he founded which, as *Meneralogische Mitteilungen*, was first issued from 1872 to 1877, in quarto form as a supplement to the *Jahrbuch der K. K. geolischen Reichsenstalt, Wien.* It took an octavo form in 1878 and continued to appear in that form till 1889, under the title *Mineralogische und Petrographische Mitteilungen.* In 1889, the editorship went over to F. Becke, who changed its title to *Tschermak's Mineralogische und Petrographische Mitteilungen.* Yet another change came over this periodical in 1930 when it was taken over by the Akademische Verlaggesellschaft in Leipzig and was made Abteilung B of the *Zeitschrift für Kristallographie Mineralogie und Petrographie.*

HONOURS.

He was elected Foreign Correspondent of the Geological Society of London in 1875. He was made a Foreign Member in 1886. He was elected an Honorary Member of the Mineralogical Society of London in 1879. In 1875, he was made a Full Member of the Kais. Akademie der Wissenschaften in Wien. He was Rector of the University of Wien in 1893. He was one of the founders and the first President of the Wiener Mineralogische Gesellschaft (1901). He was also Honorary Member of the Academies at Berlin, Göttingen, Munich, Paris, Rome, Leningrad and Sweden. He was raised to peerage in 1906 with the hereditary title Edler von Seysenigg. In 1873, F. von Kobell perpetuated his name by naming a mineral as 'tschermakite.'

PERSONALITY.

Professor Dana describes him as a charming courtly gentleman. He was most kind and helpful to the younger aspirants. His popularity among all those that came into personal contact with him is demonstrated by an extraordinary gesture of regard which he experienced since 1920. The War left him in straitened circumstances. But his life was made comfortable by substantial monthly remittances from the American mineralogists who were his admirers. Although he lived to 91 years, he retained his clearness of mind almost to the day of his death—May 4, 1927.

S. R. RANGANATHAN.

Letters to the Editor.

CONTENTS.

Oxygen in Solar Prominences.

IN *Kodaikanal Observatory Bulletin* No. 107 the existence of oxygen in the solar chromosphere was demonstrated by spectrograms taken in full sunlight. The dismantling of the spectrograph for use at the solar eclipse of June 19th, 1936 makes it opportune to report progress on the results of observations of the oxygen lines in solar prominences. The lines used were the infra-red triplet at λ 7770.

When a solar prominence is on the slit of the spectrograph, the oxygen triplet is found to be present, although always very faint. The conditions for photographing the oxygen triplet in a prominence are more easily attained than those for photographing it in the chromosphere since there is less difficulty with the tremor of the sun's limb, but the demonstration of the oxygen triplet reversals in a prominence is less frequently successful on account of the faintness of these lines in prominences compared with the sky spectrum. It is necessary to have a bright prominence and a blue sky to show the oxygen triplet brightly reversed against the sky spectrum.

The best results so far were obtained in a narrow prominence on the 11th December, 1935. The lines of the oxygen triplet were found in this prominence at a height of about 20″ above the chromosphere, or 9,000 miles. There was no possibility of these lines being due to chromospheric light, as the reversals were short in length corresponding to the short length of the prominence on the slit.

The photometry of these faint lines in full sunlight will always be a matter of difficulty on account of the presence of the sky spectrum and it seems best to wait until eclipse photographs are available for oxygen lines.

Kodaikanal Observatory, A. L. NARAYAN.
March 20, 1936. T. ROYDS.

Absorption Spectra of Halides and Oxyhalides of S, Se, and Te.

IN continuation of earlier work on the chlorides and oxychlorides of sulphur,[1] we have measured the absorption spectra of a number of halides and oxyhalides of S, Se, and Te in the vapour state. The observed maxima of selective absorption together with their long wave limits are listed in Table I and we have added also the bond energies (in K. cal/mol) corresponding to the correlated

TABLE I.

	I Absorption				II Absorption				III Absorption				IV Absorption			
	Red wave lim.		Maximum		Red wave lim.		Maximum		Red wave lim.		Maximum		Red wave lim.		Maximum	
	λ (mμ)	Kcal/mol	λ (mμ)	Volts.	λ (mμ)	Kcal/mol	λ (mμ)	Volts	λ (mμ)	Kcal/mol	λ (mμ)	Volts	λ (mμ)	Kcal/mol	λ (mμ)	Volts
$SOBr_2$					378	75	327	3·7	281	101	265	4·6	245	116		
					$2 D_B$ (S — Br) = 74				$2 D_B$ (S—Br*) = 95				D (S = 0) = 116			
Se Cl_4	(415)	(68)	325	3·8					301	94	275	4·5	(250)	(114)	(240)	(5·1)
SeO Cl_2									315	90	266	4·6	250	114		
Se_2Cl_2					410	69	350	3·5	320	89	295	4·2	249	114	(237)	(5·2)
	D_B (Se—Cl) = 47				D (Se_2) = 59				$2D_B$ (Se—Cl) = 94							
Se Br_4	580	47	490	2·5	530	55	427	2·9	350	81	262	4·7	250	114		
Se_2 Br_2					465	61	384	3·2	350	81	322	3·8	288	98	257	4·8
	D_B (Se—Br) ~ 42				D_B (Se—Br*) ~ 53 D (Se_2) = 59				$2 D_B$ (Se—Br) ~ 84				$2 D_B$ (Se — Br*) ~ 106 D (Se = Se*) = 87			
Te Cl_2	480	59	317	3·9					290	98	251	4·9	246	115		
Te Cl_4	480	59	324	3·8					272	105	247	5·0				
	D_B (Te—Cl) = 55								$2 D_B$ (Te—Cl) = 110							
Te Br_2	535	53	473	2·6	420	67	380	3·2	340	84	314	3·9	293	97	(228)	5·4
Te Br_4	525	54	465	2·7			(400?)		296	96	265	4·6	(249)	(114)		
	D_B (Te—Br) = 48				D_B (Te—Br*) = 59				$2 D_B$ (Te—Br) = 96				$2 D_B$ (Te*—Br) = 124 $2 D_B$ (Te—Br*) = 108			

processes of photo-dissociation. D_B denotes values calculated from thermo-chemical data, *e.g.*, D_B (Te – Cl) is one quarter of the heat of formation of $TeCl_4$ from the gaseous atoms (not from the elements), D denotes a value taken directly from the band spectra of the diatomic molecules. Wherever a dissociation involves excited products, this is marked by an asterisk against the atom undergoing excitation. Some of the thermo-chemical data, particularly the latent heats of the compounds, are uncertain, and, as discussed elsewhere, it is difficult to determine that value of the long wave limit, which belongs to the molecule in its lowest state of vibration. Considering this, the agreement is very satisfactory.

Similar to the spectrum of S Cl_2, the di= and tetrahalides possess different regions of selective absorption in which at first one and then a second halogen atom is split off. From those molecules containing a double bond, *e.g.*, the mono = and oxyhalides, always two halogen atoms are split off simultaneously. The breaking up of the double bond is observed where its energy value comes in the region under observation and the same holds for the dissociation of excited atoms, which can be observed for instance in the second and fourth region of selective absorption of the di = and tetra bromides, the electronic separation of the chlorine atom (881 cm.$^{-1}$), being too small to be resolved in the spectrum.

These results confirm entirely the conclusions, drawn from the corresponding photo dissociations of the chlorides and oxychlorides of sulphur and of other molecules. Furthermore, since the process of photo-dissociation determines the energy value of an individual bond directly, and not as part of a grand total as in thermo-chemical experiment, it can be seen that the bond energies are approximately additive in the same molecule and remain approximately constant in all the di = and tetravalent molecules. This result can hardly be understood otherwise than in a pair bond theory of valency, in which each linkage is produced by a pair of electrons, one from each atom, and localised between them.

A detailed report will be published elsewhere.

S. L. HUSSAIN.
R. SAMUEL.

Department of Physics,
Muslim University,
Aligarh,
April 5, 1936.

[1] R. K. Asundi and R. Samuel, *Proc. Phys. Soc.* (London), **48**, 28, 1936; Mohd. Jan Khan and R. Samuel, *Ibid.*, in Press.

Note on the Raman Spectra of Metallic Formates and the Constitution of Formic Acid.

IN a recent paper[1] I have shown that the formates of sodium, calcium, cadmium and lead yield Raman lines both in the state of solid and aqueous solutions, the average frequencies of which are 2834, 2732, 1717, 1534, 1347 and 851 cm.$^{-1}$ Besides, in the solids two other frequencies are also present at 2976 and 1397. The frequency shifts in the sodium formate solution have since been confirmed by Edsall.[2] Of these frequencies 2834 was assigned by me to the valence oscillation and 1347 to the deformation oscillation of the HCO group in the formate ion. The origin of the line at 1534 which is of medium intensity in the lead formate crystals was then considered to be uncertain.

In view of the doubt expressed by Halasyam[3] regarding the assignment of 2834 and 1347, I may indicate the following points in support of my conclusion as to the existence of the aldehyde group in the formic acid.

1. In general, the Raman frequencies between 2600–3400 in the organic substances have their origin in the valence oscillations of the X—H bindings.[3] In the case of the formate ion (HCO_2^-), only two forms of X--H are possible, namely, CH (aldehyde group) or OH (Ray-Sarkar[5]). The OH frequency is always higher than 3300 and hence the only possible bond to which 2834 could be ascribed is the CH.

2. The absence of any line at about 3300 even in the fairly intense spectrum of lead formate crystals indicates the non-existence of any OH group in the ion.

3. In the crystals of lead and calcium formates a weak line was present at 2973 which coincides with the CH frequency in the formic acid.

4. In their detailed study of 16 aliphatic aldehydes R.CO.H (with R=H to R=C_9H_{19}) Kohlrausch and Köppl[6] observe "ω=1379 in H.CO.OR and ω = 1390 in H.CO.R sind vermutlich die CH Deformationsfrequenzen des endständigen Wasserstoffatoms; an der Stelle 1390 weisen dementsprechend auch Formamid (H.CO.NH[2]) und Ameisensaure (H.CO.OH) kräftige Linen auf." The corresponding line in all the formates appears

at about 1347 and is the most prominent line in their spectra. It is interesting to note that the ratio of this frequency of the formates to the line 2834 representing the valence oscillation is practically the same as the ratio between the corresponding lines in the formic acid or other aldehydes.

The large shift from 2963 in the formic acid to 2834 in the aqueous solutions of the formates is evidently to be attributed to the influence of the field of the neighbouring ions on the CH group, *tending to diminish the binding force between the carbon and the hydrogen atoms*. This does not mean complete rupture of the CH bond as is apparently supposed by Halasyam (*loc. cit.*). The CH frequency is known to be very sensitive to the influence of the surroundings.[7] It has as low a value as 2867 in chloral ($H.CO.CCl_3$) or 2882 in formamid ($HCO.NH_2$) which are not far from 2834 observed by me in the formate ion. A comparison of similar influences on the CH frequency in acetates, propionates, etc., with those of formates is not justifiable; because in the former there are other CH_2 groups present whose vibrations are not affected in the same manner as those of the CH attached directly to the ion as in $\left[\mathrm{H.C}\begin{smallmatrix} /\!\!/\mathrm{O} \\ \backslash\mathrm{O} \end{smallmatrix}\right]^{-}$ and which give rise to the line in the unshifted position. It may, however, be pointed out that even in the case of the acetates a similar lowering of the frequency could be inferred from the results of Edsall (*loc. cit.*) who has reported a weak line at 2851 in sodium acetate while there is no line below 2936 in the 33% aqueous solution of acetic acid.

These facts point definitely to the conclusion that *the Raman spectra data of formates indicate the presence of the aldehyde group in the formic acid and do not support the alternative constitution proposed by Ray.*[5]

If we neglect for a moment, H in the ion $\left[\mathrm{H.C}\begin{smallmatrix} /\!\!/\mathrm{O} \\ \backslash\mathrm{O} \end{smallmatrix}\right]^{-}$ the line at 1534 as well as the two other lines 1717 and 857 in the formates could be explained as due to the vibrations of the configuration $\mathrm{C}\begin{smallmatrix} /\!\!/\mathrm{O} \\ \backslash\mathrm{O} \end{smallmatrix}$ considered as a non-linear molecule of the XYZ type. For such a molecule three distinct modes of vibration are possible and the line 1534 which is more intense than the other two may correspond to the vibration with the maximum possible symmetry.

C. S. VENKATESWARAN.

Physics Department,
Indian Institute of Science,
April 4, 1936.

[1] Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (**A**), 1935, **2**, 615.
[2] Edsall, J. T., *Jour. Chem. Phy.*, 1936, **4**, **1**.
[3] Halasyam, R. M., *Curr. Sci.*, 1936, **6**, 651.
[4] Kohlrausch, *Der Smekal-Raman Effect*, 1931, 151.
[5] Ray, P. C., *Nature*, 1934, **133**, 646.
[6] Kohlrausch and Köppl, *Z.f. Phys. Chem.*, 1934, **24**, 370.
[7] Kohlrausch, *Der Smekal-Raman Effect*, 1931, 160.

A New Groundnut *Arachis hypogœa*, Linn. Var. *Gigantea* Patel et Narayana (*Var. Nova*).

Derivavit ab A. H. 32 × A. H. 17; generatio vera.

Typicus: ad Agricultural Research Station, Tindivanam.

Properitas ex *Arachis hypogœa*, exceptio:
(i) Rami 5′ longi, et humiles.
(ii) Flores in spicum, bracteatæ, laxum; axis ex inflorescentia 4″–8″, elongatus.

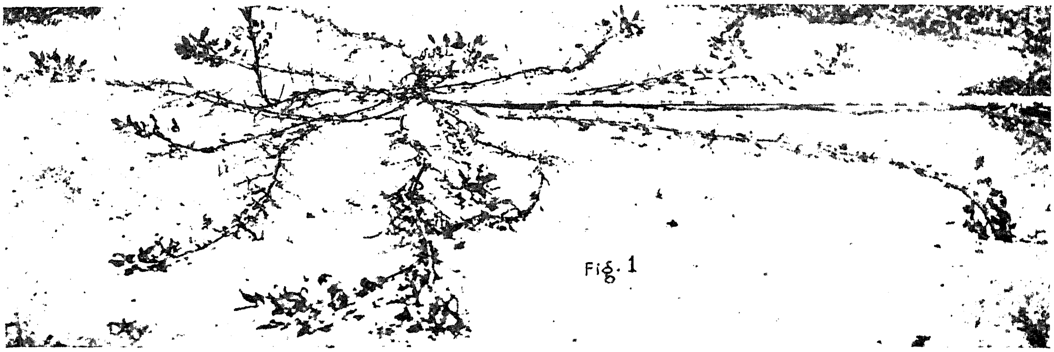
Two types of habit are commonly recognised in groundnut, *viz.*, the bunch and the spreading. The habit of growth of the bunch type is characterised by the primary branches rising obliquely from the base of the main axis, while in the spreading the primaries are procumbent.

From the progenies of a cross between a bunch variety, *viz.*, A. H. 32 Gudiyattam bunch and a spreading variety A. H. 17 Madagascar a strikingly new, hitherto undescribed variety (Fig. 1) has been isolated; and this has been breeding true.

The chief distinguishing feature of this variety is the extraordinary length of the primary and secondary branches which are robust and grow up to an average length of 5′ and radiate on all sides and are entirely prostrate or trailing throughout their length. The main axis which is erect at first, attains, unlike their parents, a height of about 2′ and assumes a procumbent habit as the plant advances in age and produces numerous gynophores or pegs even from the nodes higher up the main axis.

In none of the varieties or the species of groundnut such extraordinary long branches are met with.

Another striking character which distinguishes the plant from other varieties or progenies of other crosses is its inflorescence.



Entire plant 1/10 natural.

In parents, as a matter of that, in any other groundnut variety or species including *Arachis Rosteiro* and *Arachis nambyquaræ*, Hoehne, the inflorescence is an axillary cluster of flowers on a congested axis (Fig. 3) rarely elongating on maturity to about ½″ or so. This short axis is normally hidden inside the stipular sheath. But in this new variety the rachis (Fig. 2) is considerably elongated and grows out as the flowers open and attain a length of about 4″ to 8″ with distinct nodes and corresponding bracts. The nodes may have gynophores or pegs which develop normal pods.

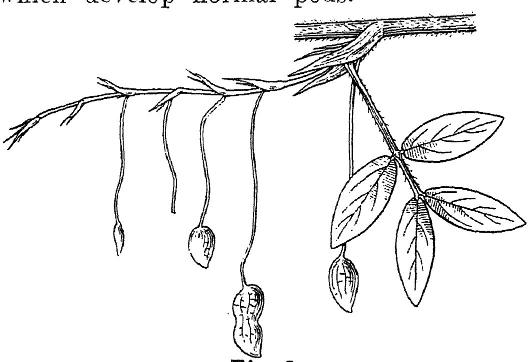


Fig. 2.
Inflorescence of the new variety (natural size).

The base of the main axis is very thick and rather woody. Other morphological characters are similar to those of the ordinary groundnut plant, though the leaves, stem and flowers, etc., are proportionately bigger than those of the male and the female parents.

According to *Linnæus*, the dense axillary and sessile spikes form the characteristic of the inflorescence of the genus *Arachis*; but the spikes of the new variety are lax, elongated as mentioned above and are sufficiently distinguishing to form at least a new species. Since it crosses rather freely with the other varieties of *Arachis hypogæa*, it has been given the status of only a variety and not a species.

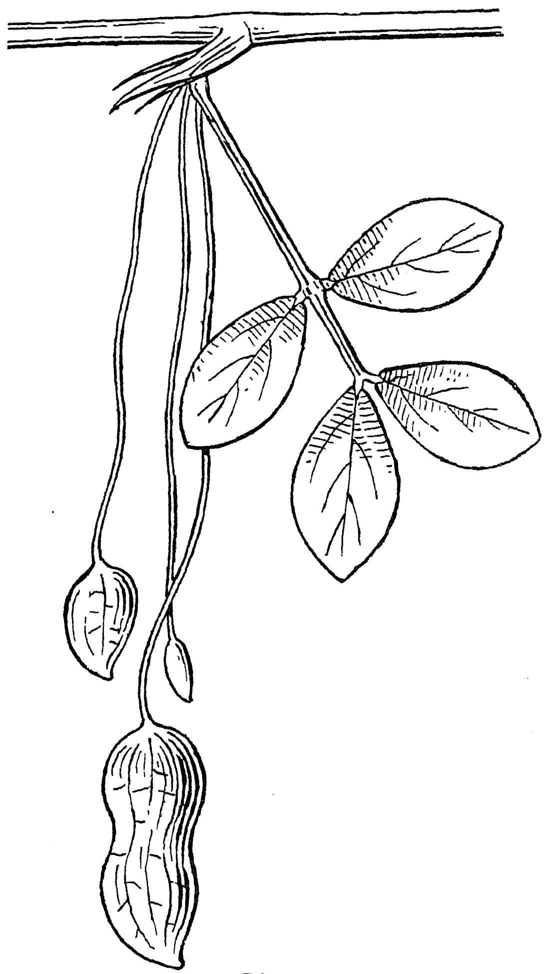


Fig. 3.
Inflorescence of *Arachis hypogæa* (natural size).
Digera Arvensis.

C. M. JOHN.
Oil Seeds Section, C. R. SESHADRI.
Agricultural Research Institute,
Coimbatore,
February 27, 1936.

Chromosome Numbers in *Dolichos lablab* (Linn.) and (Roxb.).

THE chromosome numbers in *lablab* have been recorded by Karpechenko (1924)[1] as 22 and by N. S. Rau (1929)[2] as 24 in the somatic cells. Kawakami (1930)[3] reports 11 as the haploid number. The present investigation was done to reconcile these varying records.

Advantage was taken of the wide collection of *lablab*, both field and garden varieties to pick typical varying material for examination. Types of plant pigmentation, seed colour, pod shape and consistency from both field and garden varieties were examined. To this material was added the examination of F_1 plants from crosses between garden and field varieties. Altogether material from nine sources were taken. Flower buds about 2 mm. long were fixed between 9 and 10 A.M. after removing the calyx. Root-tips from seeds sown in saw dust were collected every hour from 6 A.M. to 6 P.M. and those collected between 6 A.M. and 7 A.M. gave the best plates for counting.

The metaphase plates in pollen mother cells showed 12 bivalents. The plates from root-tips gave 24 chromosomes. In the F_1 material no irregularity in chromosome separation was noticed. It will thus be seen that the chromosome numbers in *Dolichos lablab* (Linn.) and (Roxb.) are $2n$–24.

Nemec (1910)[4] records the $2n$ chromosome number in *D. multiflorus* as 24. N. S. Rau (1929)[2] finds 12 as the haploid number for *D. biflorus* (Linn.). The numbers observed for *D. lablab* are thus the same as those recorded for the two others, *Dolichos biflorus* (Linn.) and *Dolichos multiflorus*.

G. N. RANGASWAMI AYYANGAR.
N. KRISHNASWAMY.

Millets Breeding Station,
Coimbatore,
March 5, 1936.

[1] *Bull. Appl. Bot. Plant Breeding*, 1924–25, **14**, 143. (Abstract in *Bot. Abs.*, 1926, **15**, entry 4919, 728.)

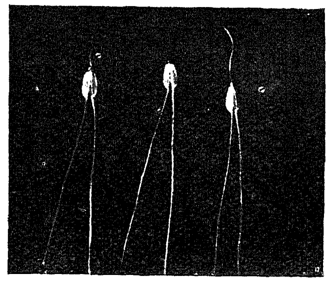
[2] *Jour. Ind. Bot. Soc.*, 1929, **8**, 201.

[3] *Bot. Mag., Tokyo*, 1930, **44**, 319–28 (from Gaiser, *Bibl. Genet.*, 1933, **10**).

[4] From Gaiser, *Bibl. Genet.*, 1930, **6**.

Double Awned Spikelets in Rice.

DURING the rice season of 1935–36 a single plant culture in the F_3 generation of a cross between the Karjat wild rice and a Burmese type was noted with some of the plants showing double awned spikelets confined to the upper part of the panicle branch (see photograph). In such plants not all the spikelets were double awned. There was variation in the number of double awned



spikelets in different panicles of the same plant.

The progeny consisted of 29 plants with some double awned spikelets and 10 plants with normal one-awned spikelets. No such condition was observed in the F_2. All the double awned spikelets were sterile. The material will be grown through further generations to see whether the condition is hereditary and fuller details will be reported in due course.

B. S. KADAM.
G. G. PATIL.
V. K. PATANKAR.

Rice Breeding Station,
Karjat, Kolaba,
February 28, 1936.

Chromosome Numbers in Cymbopogon Species.

THE Genus Cymbopogon (Gramineæ) is of considerable economic importance, in that it contains a number of species, which yield essential oils known in trade, as Lemon grass oil, Citronella oil, etc. But except the taxonomy of the various species, practically very little is known about their cytology. A study bearing on this subject has been undertaken by the author in the Oil Seeds Section of the Agricultural Research Institute, Coimbatore, with the South Indian material. Fischer (1934), in the *Flora of the Presidency of Madras*, Part X, mentions nine species occurring in South India. Five species have so far been worked out and

the chromosome numbers have been determined, as mentioned below.

Name of plant.	($2n$) No.	(n) No.
Cymbopogon polyneurus	..	10
,, *cæsius*	20 ?	10 +I
,, *flexuosus*	40	20
,, *coloratus*	40	..
,, *citratus*	40	..

The remaining species are being investigated.

My thanks are due to Dr. J. S. Patel, the Oil Seeds Specialist, who has suggested this investigation and who has given me the necessary facilities for work and his valuable guidance.

C. N. Babu.

Oil Seeds Section,
Agricultural Research
Institute, Coimbatore,
February 3, 1936.

Internal Proliferation in *Carica papaya* Linn.

Carica papaya is very variable under cultivation. The object of the present note is to describe a peculiar teratological phenomenon in *Carica* known as "internal" proliferation. Several small fruits found within big fruits of *Carica papaya* were sent to the authors, after the parent fruits were either eaten or destroyed. Figs. 1 and 2 show the small fruits varying in shape from oblong to napi-form. Fig. 3 shows a longitudinal and two transverse sections of the young fruit pictured in Fig. 1.

These fruits, as we are informed, were borne at the base of the parent fruits. Sections show that there is only one loculus in each and the seeds are in the normal position, that is, parietal. The fruits pictured in Fig. 2 show no seeds in them, but the whole morphological structure goes to show that they are also carpellary bodies, although further work must be done to confirm this statement.

So far as we are aware of, such a case has not been recorded in *Carica papaya*, although the abnormalities of the leaves are on record. Worsdell has mentioned under the heading of "Adventitious Flowers," a case of adventitious grapes which he has figured from Masters. This is a similar case, and it is preferred to call it "internal" proliferation rather than class it under "adventitious

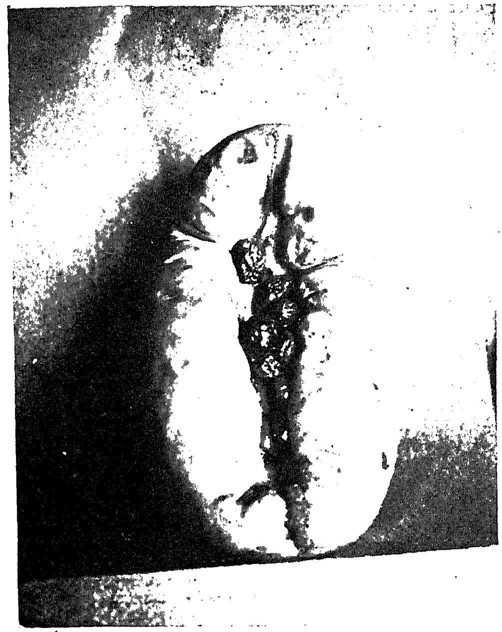


Fig. 1.

Fig. 2.

Figs. 1 & 2. Small abnormal fruits found in two big fruits of *Carica papaya* Linn.

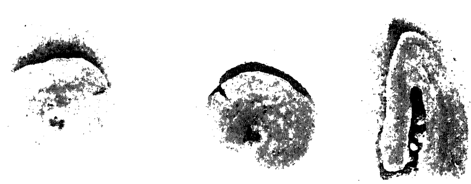


Fig. 3.

L. S. & T. S. through the fruit pictured in Fig. 1.

flowers". Recently Bausor has described a "Monstrous Fruit of Capsicum" which exhibits central or "internal" proliferation, exactly similar to our present case. In the case of Fig. 1, there can hardly be any doubt that it is a true pistil, but in the case of Fig. 2 the "fruits" are solid structures with no seeds in them. Hence it is doubted that they are not true pistils in the strict sense of the term. Perhaps they are solid carpels, as Bausor says.

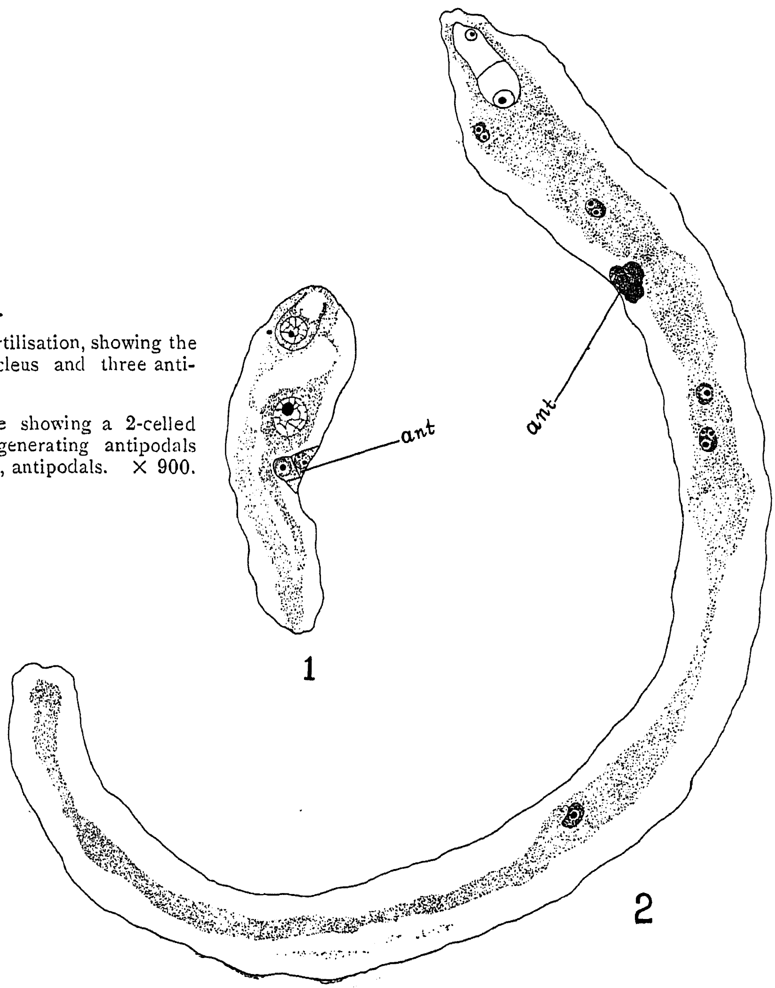
More detailed investigation is in progress, and it is hoped to throw more light on this problem shortly.

M. SAYEEDUDDIN.
A. BARI.

Botany Department,
Osmania University,
Hyderabad,
April 5, 1936.

A Note on the Antipodals of *Digera arvensis* Forsk.

ALTHOUGH the embryo-sac of *Digera arvensis* has been studied recently by Naithani,[1] Joshi and Rao[2] and Puri and Singh,[3] the behaviour of the antipodals does not seem to have been rightly followed so far. Both Naithani and Joshi and Rao have described the antipodals in *Digera* to degenerate early. A recent study of the embryo-sac undertaken in connection with the development of the embryo in this species shows that these observations are not true. It appears that generally the antipodals persist even after fertilisation. During the secondary elongation of the embryo-sac, which starts with fertilisation, the chalazal end of the embryo-sac grows along one side of them and they are left behind on one side of the embryo-sac (Fig. 1), just as Kajale[4]



Digera arvensis.

FIG. 1.—An embryo-sac just after fertilisation, showing the oospore primary endosperm nucleus and three antipodals on one side.

FIG. 2.—The same at a later stage showing a 2-celled proembryo, endosperm and degenerating antipodals in their original position. *ant.*, antipodals. × 900.

in a previous communication from this department has found to be the condition in *Alternanthera sessilis*. Some examples from other families of the flowering plants in which a similar situation has been found are mentioned in Kajale's paper. Recently Mr. C. V. Rao of P. R. College, Cocanada, in a letter to me reports the same condition in a species of *Iresine*, another genus of the *Amaranthaceæ*. This behaviour of the antipodals is therefore quite likely to be characteristic of the family.

The antipodals in *Digera arvensis* remain in this position on one side of the embryo-sac until the early stages of embryo-development, up to the 2-celled stage or so, though they begin to degenerate by this time. The embryo-sac by this time has reached a considerable length (Fig. 2).

A. C. JOSHI.

Department of Botany,
Benares Hindu University,
March 31, 1936.

1 *Bull. Acad. Sci., U.P.*, 1933, **3.**
2 *Jour. Ind. Bot. Soc.*, 1934, **13.**
3 *Proc. Ind. Acad. Sci.*, 1935, **1 B.**
4 *Ibid.*, 1935, **2.**

A Preliminary Note on the Embryology of *Duabanga sonneratioides* Ham.

THIS note presents briefly the results of a detailed study of the embryology of *Duabanga sonneratioides*. This plant is a member of Sonneratiaceæ, one of those families of Myrtifloræ that has received very scant attention from students of angiosperm-embryology. So far the only species investigated, as cited by Schnarf[7] in his recent book, is *Sonneratia apetala* worked out by Karsten,[5] and this work dates as far back as 1891, besides being of fragmentary nature. Another point of interest relating to this family is that the genera included in it are placed by some systematists in the Lythraceæ and by others have been raised to the status of a separate family. Therefore it has been thought worthwhile to examine the embryological features of one of these genera.

The ovules are numerous and are borne on large axile placentæ. They are anatropous, with a fairly thick nucellus and two-integumented. Both the integuments take part in the formation of the micropyle. The primary female archesporium very frequently extends to more than one cell, and more than one functioning archesporial cells are occasionally met with. A parietal cell is cut off, which by subsequent divisions forms 4–5 cells thick parietal tissue above the embryo-sac. The megaspore-mother cell undergoes the heterotypic and homotypic divisions forming the normal linear tetrad. The homotypic division in the chalazal dyad usually precedes that in the micropylar dyad. The chalazal megaspore is the functional one and develops in the normal manner into an 8-nucleate embryo-sac after 3 successive nuclear divisions. The mature embryo-sac (Fig. 1) is 4-nucleate, just as in the Lythraceæ, [1,2,3,4,6,9] due to the early

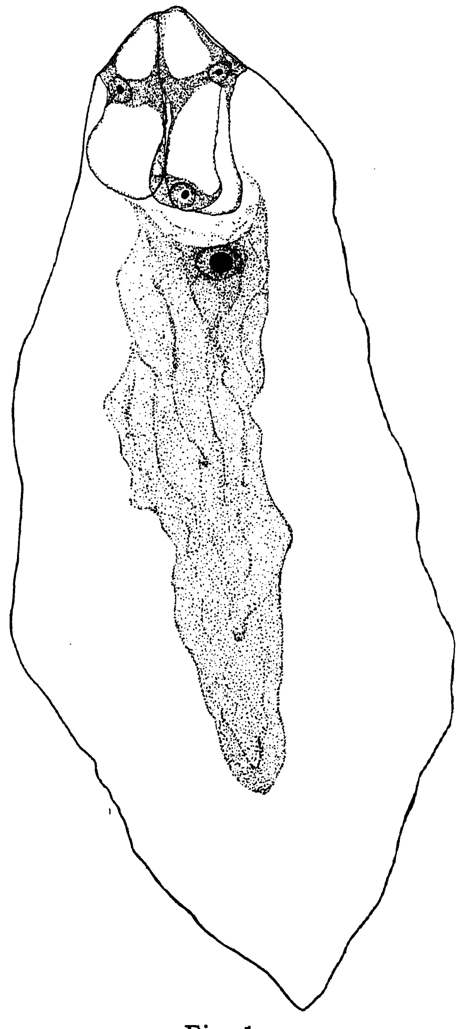


Fig. 1.
Duabanga sonneratioides, Mature embryo-sac. × 1650.

degeneration of the antipodals. The synergids are hooked and have a small vacuole in their micropylar apex in addition to the usual very prominent chalazal vacuole,

A single nucleus is situated between the two vacuoles. The egg has the usual form.

The nucellus shows a chalazal strand of specially differentiated cells connecting the antipodal end of the embryo-sac and the vascular bundle of the ovule, just as in the Lythraceæ.[2,3,4]

The fertilisation is porogamous. The endosperm is nuclear in the early stages but becomes cellular in the later stages of seed development. The development of the embryo takes place according to the *Capsella* type and agrees in all essential points with that of the Lythraceæ.[4,8]

On the whole, the embryology of *Duabanga sonneratioides* shows a close resemblance with the embryological features of the Lythraceæ, which have been described in detail recently by Prof. Joshi and the writer.[1,2,3,4]

I desire to express my sincere thanks to Prof. A. C. Joshi for helpful suggestions during the progress of the work. I am also indebted to Mr. I. Banerji of Calcutta University for a part of the material used in this investigation.

J. VENKATESWARLU.

Department of Botany,
Benares Hindu University,
March 19, 1936.

[1] Joshi, A. C., and Venkateswarlu, J., *Ann. Bot.*, 1935, **49**, 196.

[2] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1935, **2**, No. 5.

[3] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1935, **2**, No. 6.

[4] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1936, **3**, No. 4,

[5] Karsten, G., *Bibl. Bot.*, 1891, **22**.

[6] Mauritzon, J., *Medd. Goteborgs Botaniska Trädgärd*, 1934, **9**.

[7] Schnarf, K., "der Angiospermen," Berlin, 1932.

[8] Souéges, R., *C. R. ac. Paris*, 1925, **180**.

[9] Tischler, G., *Ber. d. Deutsch. Bot. Ges.*, 1917, **35**.

Embryo Development in *Boerhaavia diffusa* Linn.

THE development of the embryo in *Boerhaavia diffusa* has been described by Dr. Maheshwari[1] to correspond to the *Capsella* type. This is wrong and the mistake has probably arisen on account of the incomplete observations of the various stages in development. It appears that 3 apical cells of the pro-embryo take part in the development of the embryo, excluding the root tip, and the embryo-development either corresponds to Chenopodiaceous or Caryophyllaceous type. Full details shall be published by the writer shortly elsewhere.

L. B. KAJALE.

Benares Hindu University,
April 4, 1936.

[1] Maheshwari, P., *Jour. Ind. Bot. Soc.*, 1929, **8**, 219–234.

The Ram Sarcophagus.

WHETHER the Sarcophagus from Sankhavaram described by me[1] is ram-shaped, is questioned by Mr. Govinda Menon[2] on the grounds that the head does not show the ears, the Sarcophagus has six legs, and the curling excrescences from the sides of the head are wings rather than horns. The rams among the bronze antiquities from Adichanallur are modelled without ears but with large horns as in the Sankhavaram Sarcophagus. As regards the number of legs, all cists of this size have more than four legs, as the potter's handiwork requiring more legs to support the torso of the animal than nature's. If a head removable from the torso were invested with a pair of "sturdy wings", the flighty head must have had a purpose we cannot trace. Were the whole object a bird, one would rather have expected that the wings would be attached to the torso, and not to the detachable head that could fly away leaving the torso and the bones behind. If the torso is bulkier in proportion to the head, it is because the torso, and not the head, was to be the receptacle for the bones.

I should therefore decline to follow in the wake of Mr. Govinda Menon when he passes on to speak of composite animals and the primitive mind.

Perhaps I may add that the Cochin Sarcophagus came to my notice shortly after my paper was prepared.

M. D. RAGHAVAN.

Government Museum,
Madras,
March 12, 1936.

[1] *Curr. Sci.*, 1935, **4**, No. 5.

[2] *Curr. Sci.*, 1936, **4**, No. 8.

The Vertebral Column of the Anura.

By Beni Charan Mahendra,
St. John's College, Agra.

WHILE looking through the first volume of *Current Science* at random the other day, I came across a note by Mookerjee[1] and an article by Ramaswami,[2] which have especially interested me. Both these authors appear to have started their investigations on the vertebral column of some frogs by a perusal of Nicholls' note[3] in *Nature* (1914) about the vertebræ of the genus *Bufo*, and to have assumed that no further papers existed on this subject criticising the older, more prevalent view of such authors as Boulenger (1897),[4] Gadow (1901)[5] and others. As a matter of fact, however, Beddard[6] in 1907 pointed out "the procœlous excavation of the vertebral centra" in *Megalophrys nasuta*, contrary to what Boulenger had believed, and Boulenger[7] himself in 1908 confirmed Beddard's finding and added, "but at the same time I find the vertebræ to be procœlous also in some specimens of *M. montana*, the type of the genus, and of *M. longipes*, of which species other specimens showed them to be opisthocœlous. It is therefore clear that the character, however important it may appear at first, is worthless even as a specific character in these Batrachians." In this connection, perhaps the most important work is a detailed article[8] by Nicholls in the *Proceedings of the Linnean Society of London* (1915–1), and unfortunately both Mookerjee and Ramaswami have overlooked it. Nicholls examined "practically the entire collection of Anuran skeletons in the British Museum," in all "over four hundred vertebral columns of some fifty genera of Anura"; and it is almost certain that a reference to his paper might have saved Mookerjee all the labour of preparing his note, and Ramaswami some unnecessary duplication of work.[9] A comparison of all the three articles shows that Mookerjee's observations on the eight vertebra of *Rhacophorus maximus* has been completely anticipated by Nicholls,[10] who seems to feel the inadvisability of admitting this genus into the family *Ranidæ*. He says:

"A more puzzling exception is met with in the genus *Rhacophorus*, and there can be, I think, in this case, no question of abnormality or individual variation.

"The genus is one in which Boulenger has merged the genus *Polypedates*, and it is represented, in the British Museum collection of skeletons, by nine specimens. Of these, four, belonging to the species *R. maculatus*, *R. cruciger*, *R. macrotis*, and *R. robustus*, were diplasiocœlous.[11] The remaining specimens, *R. maximus*, *R. madagascariensis*, *R. schlegelii*, and *R. reinwardtii*, were uniformly procœlous.[12]....

"Such a condition is apparently inexplicable in view of the fact that the *Rhacophori* are generally accepted as true Ranidæ. It is, however, of peculiar interest in view of the fact that the *Rhacophori* have not always been regarded as *Ranidæ*. Originally they were placed with the Hylidæ (which are of course procœlous), to which they bear a most remarkable resemblance which is, at the present time, attributed merely to convergence. How close is this resemblance may be judged from a fact

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[1] Mookerjee, H. K., *Curr. Sci.*, 1932, **1**, 165.

[2] Ramaswami, L. S., *Curr. Sci.*, 1933, **1**, 306.

[3] Nicholls, Geo. E., *Nature*, 1914, **94**, 420.

[4] Boulenger, G. A., "The Tailless Batrachia of Europe," 1897, p. 38.

[5] Gadow, H., "Amphibia and Reptiles," *Camb. Nat. Hist.*, 1901, 20 (reprinted in 1923).

[6] Beddard, Frank E., *Proc. Zool. Soc.*, London, 1907, **1**, 328.

[7] Boulenger, G. A., *Proc. Zool. Soc.*, London, 1908, **1**, 407.

[8] Nicholls, Geo. E., *Proc. Linnean Soc.*, London, **1915-16**, Session **128**, **80–92**.

[9] I must admit, however, that Mookerjee and Ramaswami's work has a confirmatory value, and that Ramaswami has added materially to our knowledge in this respect.

[10] Nicholls, Geo. E., *op. cit.*, 1915–16, 89–90.

[11] The term "Diplasiocœlous" was suggested to Nicholls by Boulenger, and was proposed by Nicholls to designate "those vertebral columns, hitherto described as procœlous, which have *only the first seven* vertebral centra hollow in front, the eighth hollow upon both faces and the ninth doubly convex." The term is really good and should be employed more widely than it has so far been done.

[12] The term "*procœlous*" has been loosely used by most authors to designate even such a vertebral column as is found in *Rana*. Strictly speaking, it should be employed ouly to those cases where *all* the vertebræ have their centra concave anteriorly. This term has been used only in its correct sense in the present article, and it is hoped that other authors also will use it in its strict meaning so as to avoid needless confusion.

recently brought to light by Stejneger[13] (1907). This author has pointed out that the specimen originally figured by Schlegel and regarded as the type of *Polypedates* (*Rhacophorus*) *schlegelii* is actually a mere variety of *Hyla arborea* (*H. arborea japonica*). This view, he remarks (1907, p. 77), has been confirmed by an examination of the original specimen in the Leiden Museum. He figures this variety of *Hyla* as possessing the tongue typical of the Hylidæ but as having a foot which, so Mr. Boulenger informs me, is absolutely characteristic of *Rhacophorus*."

One should like to point out, however, that even if the genus *Rhacophorus* is shifted from the family Ranidæ to one of the families (*viz*., *Bufonidæ*, *Hylidæ and Cysitgnathidæ*) forming the tribe *Procœla* of Nicholls, the difficulty is hardly solved, as this genus includes both procœlous and diplasiocœlous forms and a suitable explanation would then be required of the presence of the Ranid type of the vertebral column in some species of this genus.

Ramaswami's observations[14] fully confirm Nicholls' on the vertebræ of *Rhacophorus*, and also add *R. eques* to the diplasiocœlous, and *R. dubius* and *R. microtympanum*, to the procœlous forms. This latter author also feels the position of *Rhacophorus* as problematic and says: "Possibly an examination of other species of this genus may reveal a similar divergence and if it be so, then we have clearly included in this genus *Rhacophorus*, two groups which, so far as the character of the 8th and 9th vertebræ is concerned, will have to be dissociated. Whatever may be the nature of these vertebræ the transverse process of the 9th vertebra is typically Ranid in the forms examined by me, and this fact should not be lost sight of in the investigation of the other species of *Rhacophorus*."

Apparently in view of these studies, three questions arise bearing on the taxonomic status of the genus *Rhacophorus*, and we hope that later workers who have access to the necessary material, will throw some light on them. *First*, how far can we justifiably include within the same genus species so much differing from each other in the nature of their vertebral centra; *secondly*, is it really advisable to include this

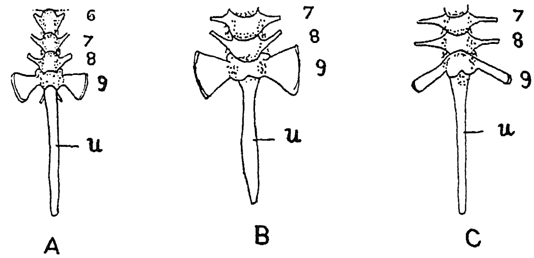

Fig. 1.

Ventral View of the hinder part of the Vertebral Columns of (A) *Discoglossus pictus*, (B) *Bufo andersonii*, and (C) *Rana tigrinal*, to show the opisthocœlous, procœlous, and diplasiocœlous condition (After Nicholls).

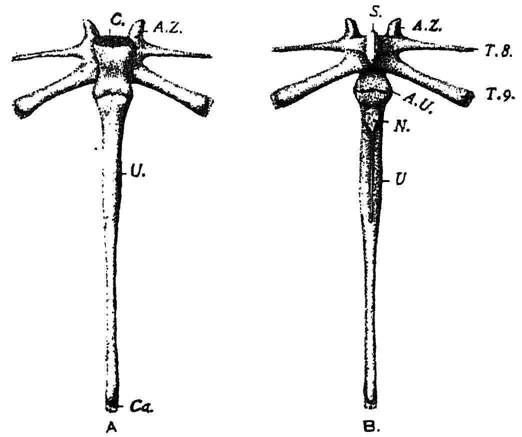

Fig. 2.

The fused 8th and 9th vertebræ and the Urostyle of normal *Rana curtipes*.

A. Ventral View. B. Dorsal View.

A.U., Articulation of the last vertebra with the urostyle; *A.Z.*, Anterior Zygapophysis; *C.*, Procœlous centrum; *Ca.*, cartilage; *N.*, Bony nodule on the urostyle; *S.*, Neural spine; *T. 8.* Transverse process of the 8th vertebra; *T. 9.* Transverse process of the 9th vertebra; *U.*, Urostyle.

genus (or, at any rate, the strictly procœlous forms of it) in the family *Ranidæ*; and *thirdly*, how far are other features of organisation in the procœlous forms of this genus allied to such families as *Bufonidæ*, *Hylidæ* and *Cystignathidæ*, which are all grouped together as *Procœla* by Nicholls? It is not unlikely that the presence of both procœlous and diplasiocœlous forms in the same genus be due to a state of *plasticity* (as opposed to fixity of structure) on account of a recent state of evolution, and that the genus may help to bridge over the gap between the tribes *Procœla* and *Diplasiocœla* of Nicholls to some extent.

[13] Stejneger. L., *Smithsonian Inst. Bull. U. S. Nat. Mus.* 1907, No. 58. Washington.

[14] Ramaswami, L. S., *op. cit.*, 1933, 306.

Nicholls found that in his tribe *Diplasiocœla*, the species *Atelopus oxyrhynchus*, *A. ignescens* and *Rhombophryne testudo* belonging to the family *Engystomatidæ*,[15] as well as some species of *Rhacophorus* (*Ranidæ*), show the procœlous condition. To the procœlous types of *Ranidæ* examined by him, one can now add the following further species investigated by Ramaswami:

Ixalus chalazodes, *I. sylvaticus*, *I. nasutus*, *I. oxyrhynchus*, *Micrixalus saxicola*, *Nannobatrachus kempholensis* (n. sp., Rao).

Thus in our present state of knowledge, only the species of *Rana*[16] (except *R. curtipes*,[17] which has the eighth and ninth vertebræ fused together to form a synsacrum) and of *Nyctibatrachus*,[18] as well as the diplasiocœlous *Rhacophori* have a typically "ranid" type of vertebral column, Ramaswami's work having deducted three more genera from this group, and thus having further limited the strictly-defined "Diplasiocœla" of Nicholls. So the "ranid" type of vertebral centra does not seem to be prevalent even in the family *Ranidæ*, and it is necessary for every species to be carefully examined for this feature before a sound generalisation can be achieved. Our present knowledge of the vertebral column of Anura may be summed up as follows:

I. *Alossa*: vertebræ opisthocœlous.

II. *Phaneroglossa*:

(1) *Discoglossidæ* (Tribe *Opisthocœla* of Nicholls): vertebræ opisthocœlous; no exceptions recorded so far.

(2) *Pelobatidæ*: (Tribe *Anomocœla* of Nicholls): vertebræ procœlous. Exceptions are *Asterophrys*[19] and some species of *Megalophrys*,[20] which have opisthocœlous vertebræ.

(3) *Bufonidæ*
(4) *Hylidæ*
(5) *Cystignathidæ*

Grouped together as *Procœla* by Nicholls. Vertebræ uniformly procœlous. No exceptions yet recorded.

(6) *Engystomatidæ* (Included by Nicholls in the Tribe *Diplasiocœla*): sacral vertebra biconvex, eighth vertebra biconcave, the first seven vertebræ procœlous. Exceptions are *Rhombophryne testudo*, *Atelopus oxyrhynchus* and *A. ignescens*.[21] Many genera, however, have yet to be examined.

(7) *Ranidæ* (included by Nicholls in the Tribe *Diplasiocœla*): The forms having the diplasiocœlous vertebral column, as far as is definitely known, are species of *Rana* (except *R. curtipes*) and *Nyctibatrachus major*, *N. pygmæus*, *N. sanctipalustris*, *Rhacophorus maculatus*, *R. eques*, *R. cruciger*, *R. macrotis*, *R. robustus*. The strictly procœlous forms are *Ixalus chalazodes*, *I. sylvaticus*, *I. nasutus*, *I. oxyrhynchus*, *Micrixalus saxicola*, *Nannobatrachus kempholensis*, *Rhacophorus maximus*, *R. madagascariensis*, *R. schlegelii* and *R. reinwardtii*. Many genera and species remain yet to be examined.

With regard to the nature of the vertebral centra as a useful feature in taxonomy and classification, Ramaswami says, "Judging by the inconstancy and arbitrary nature of the centra in these forms, I think that the character of such variable structures as the vertebra may not prove a very useful criterion in the classification of these forms." Such a view is supported by Boulenger[22] (1882, 1908), Gadow[23] (1901) and some

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[15] Nicholls examined only three specimens of this family belonging respectively to the three species *Atelopus oxyrhynchus*, *A. ignescens* and *Rhombophryne testudo*. Obviously, it is necessary to examine more specimens of each of these species, as well as of others, to put his conclusions on a firmer footing.

[16] Nicholls examined 160 specimens belonging to 33 species of this genus, while Ramaswami examined only 19 species. In all, if we allow for the species examined by both these authors, we find 50 species of *Rana* investigated for this feature. All but one of these conform to the diplasiocœlous type, the only normal exception being *R. curtipes*.

[17] Investigated by Ramaswami (1933).

[18] Only three species were examined by Ramaswami and they were *N. major*, *N. pygmæus*, *N. sanctipalustris*. All conformed to the diplasiocœlous group.

[19] Sedgwick, A., *A Student's Text-book of Zoology*, **1905, 2,** 310. With reference to the family *Pelobatidæ*, he says, "vertebræ procœlous except in *Asterophrys* and *Megalophrys* where they are opisthocœlous."

[20] Sedgwick's remark about this genus (see footnote 19) is to be modified in the light of Beddard, Boulenger and Nicholl's work.

[21] Only one specimen of each of these species was examined, and hence the necessity of confirmation by examination of more examples. All the three specimens examined had procœlous vertebra.

[22] Boulenger, G. A., "Catalogue of the Batrachia *Salientia s. Ecaudata* in the collection of the British Museum" (1882) and "A revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*)" (*Proc Zool. Soc.*, 1908.)

[23] Gadow, H., "Amphibia and Reptiles", *Camb. Nat. Hist.*, 1901, **8.** He says: "The systematic value of this pro- or opisthocœlous character has been much exaggerated" (p. 19), and further, "it is not difficult to imagine that in the Anura the production of Pro or and opisthocœlous vertebræ depends simply upon the centra articulating knobs happening to fuse either with the hind or the front end of the vertebræ." (p. 20.)

subsequent authors; while Nicholls[21] (1915–16) believes implicitly in the value of this character, and thinks that "the difficulty experienced in attempting to draw hard and fast lines between the different families suggests that our classification is, in the main, a natural one and does not represent merely a convenient key." Amongst the authors who laid stress on the nature of the vertebral centra as a valuable feature in amphibian classification, mention might be made of Cope[25] (1866), Lataste[26] (1879) and Blanchard[26] (1885).

In the end, I should like to express my deep sense of gratitude to Dr. S. C. Sarkar both for kindly presenting me his valuable collection of reference papers on this as well as on other subjects and for giving me much encouragement. Without the help of friends like him, my work would hardly be possible.

POSTSCRIPT.

After having written the foregoing article, I have been reminded of Whitehouse and Grove's explanation[28] of the biconvexity of the ninth vertebra in the frog. These authors feel that such a vertebra provides a much stronger base than a procœlous one could have done, and that it thereby fulfils the extra demand made upon its strength by the movement of the pelvic girdle. This view appears to be in contradiction to Gadow's notions[29] and to lose a great deal of its weight on account of the presence of a great many exceptions in the Anura.

[24] Nicholls, *op. cit.*, 1915–16, p. 91.

[25] Cope, E. D., *Jour. Acad. Sci.*, *Pliad*, 1866, **6.**

[26] Lataste, F., *Actes Soc. Linn.*, Bordeaux, 1879, **33.**

[27] Blanchard, R., *Bull. Soc. Zool.*, *France*, 1885.

[28] Whitehouse, R. H., and Grove, A. J., *Dissection of the Frog*. Univ. Tutorial Press Ltd, London, 1933, pp. 28–29.

[29] See footnote 23 above.

The Dead Sea: A Store-House of Chemicals.

IN a paper read before the Institute of Chemical Engineers, on March 6th, Mr. M. A. Novomeysky, read a paper on "the growth of the potash industry in the Dead Sea region" (*Chem. Age*, 1936, **34**, 235). The separation of a potash salt of the grade required by the markets (80–99 per cent. KCl) from the waters of the Dead Sea by solar evaporation, is an achievement involving numerous chemical engineering problems of the first magnitude. Results of experiments led to the conclusion that to produce a high-grade carnallite with a low content of sodium chloride the process of evaporation of the mother-liquor after the separation of the common salt, should be conducted in two or even three stages. In February 1930, the Palestine Potash Ltd., began constructional work with a view to extracting salts on a commercial scale. In 1931, a bromine plant was added. The present output is 25,000 to 30,000 tons of potash and 1,000 to 1,200 tons of bromine. A carnallite with the composition of 22·23 per cent. KCl and 8·96 per cent. NaCl decomposed after its first treatment with water into a sylvinite with 50·38 per cent. KCl and 20·75 per cent. NaCl and this after the first spraying with water yielded a product containing 78·1 per cent. dry KCl. With one or more sprayings, or treatment with brine saturated with KCl, the product can be brought up to a purity of 99 per cent. KCl.

The Study of Pedagogical Anthropometry of the Goan Students.

Statistical Summary.

By Prof. J. M. Pacheco de Figueiredo,
Medical College, Nova-Goa.

THE Liceu Central of Nova-Goa is a College for secondary education, having more than 600 students, 517 of whom were studied in the Medical Propedeutics Laboratory of the Medical College of Nova-Goa, and are here reported.

These students were divided in 3 groups (Indian Hindus, Indian Christians and Luso-Descendentes) and examined biometrically and medically.

This is a summary of our report which will be published in the "*Arquivos da Escola Medico-Cirurgica de Nova-Goa*".

Biometric Examination.

By this method we examined only normal students, after having scrupulously excluded ricketts.

The following tables show figures of the measurements taken by me in students from 11 to 18 years :

TABLE I.
Height.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	cms.	cms.	cms.
11	..	130,1	..
12	137,2	135,1	138,7
13	143	143,7	144
14	146,9	150,7	146,8
15	111,6	156,9	155
16	157	158,6	159,4
17	160	162,4	164
18	159,2	163,9	164,5

TABLE II.
Chest.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	cms.	cms.	cms.
11	..	65,3	..
12	67,5	66,7	69,4
13	72,5	71,1	72,3
14	73	74,1	74,9
15	75,6	77,6	77,3
16	79	78,2	81,3
17	81,1	81,7	83,4
18	81,4	82,9	84,4

TABLE III.
Weight.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	Kgs.	Kgs.	Kgs.
11	..	25,740	..
12	30,297	27,690	30,380
13	33,086	32,330	34,280
14	34,738	36,980	38,450
15	38,837	40,980	41,000
16	41,928	43,000	49,000
17	42,000	47,900	49,709
18	45,324	47,460	50,630

TABLE IV.
Thoracic Circumferences.
(Axilar)*

Age	Indian Hindus			Indian Christians			Luso-descendentes		
	Max. mm.	Min. mm.	Dif. mm.	Max. mm.	Min. mm.	Dif. mm.	Max. mm.	Min. mm.	Dif. mm.
11	..	..	..	625	608	17	..	..	..
12	656	633	23	641	615	26	648	630	18
13	673	652	21	677	648	29	682	649	33
14	701	675	26	714	680	34	727	664	63
15	726	700	26	751	728	23	737	697	40
16	763	737	26	760	740	20	790	758	32
17	800	774	26	816	779	47	823	778	45
18	808	760	48	804	759	45	813	787	26

* Across the armpits.

TABLE IV (*b*).
Thoracic Circumferences.[1]
(Maximum and Minimum.)

Age	Indian Hindus			Indian Christians			Luso-descendentes		
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	m.m.	mm.
11	..	..	..	608	580	28	..	..	..
12	650	618	32	634	592	42	649	608	41
13	653	620	33	662	620	42	686	636	50
14	683	646	37	690	641	49	717	662	55
15	700	666	34	720	672	42	722	670	52
16	730	687	43	736	687	49	770	716	54
17	757	719	38	778	720	58	788	730	58
18	742	704	38	754	698	56	810	734	76

[1] At the level of xyphoid process.

TABLE V.

Abdominal Circumferences.[2]

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	538	..
12	561	557	569
13	565	577	596
14	587	588	622
15	605	603	613
16	606	619	654
17	638	640	662
18	624	624	648

[2] At the level of navel.

TABLE VI.

*Iliac Circumference.**

Age	Indian Hindus	Indian Christians	Luso-desendentes
	mm.	mm.	mm.
11	..	578	..
12	605	586	598
13	598	612	621
14	619	615	648
15	636	647	648
16	651	650	677
17	653	678	690
18	666	676	687

* At the level of the iliac crest.

TABLE VII (*a*).

Thoracic Diameters.

(*Axilary.*)

Age	Indian Hindus					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	134	122	12	191	178	13
13	139	125	14	192	176	16
14	138	122	16	205	188	17
15	153	139	15	206	191	15
16	152	137	15	215	201	14
17	154	140	14	227	212	15
18	157	140	17	222	205	17

Age	Indian Christians					
	A. Post.			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	135	123	12	176	165	11
12	134	119	15	183	168	15
13	140	122	18	195	175	20
14	145	130	15	200	178	22
15	153	134	19	216	196	20
16	152	139	13	219	198	21
17	156	138	18	233	210	23
18	158	136	22	237	209	28

Age	Luso-descendentes					
	A. Post.			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	143	124	19	184	160	24
13	143	124	19	202	179	23
14	158	138	20	204	175	29
15	151	130	21	213	179	34
16	163	138	25	219	194	25
17	166	145	21	235	206	29
18	165	138	27	243	208	35

TABLE VII (*b*).

Thoracic Diameters.[1]

Age	Indian Hindus					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	148	137	11	214	198	16
13	155	142	13	215	201	14
14	163	148	15	220	200	20
15	170	152	18	225	202	23
16	170	153	17	226	211	15
17	175	158	17	247	228	19
18	172	153	19	238	216	22

Age	Indian Christians					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	156	146	10	201	188	13
12	150	135	15	209	191	18
13	151	137	14	219	197	22
14	171	151	20	226	202	24
15	170	151	19	239	215	24
16	166	147	19	244	215	31
17	172	150	22	254	226	28
18	170	146	24	245	217	28

Age	Luso-descendentes					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	159	139	20	219	164	55
13	166	143	23	230	206	24
14	171	150	21	239	207	32
15	180	152	28	244	209	35
16	186	153	28	250	211	39
17	188	160	28	252	221	31
18	169	155	14	270	219	51

[1] At the level of xyphoid process.

TABLE VIII.

Bi-Acromial Diameter.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	273	..
12	297	284	294
13	300	307	297
14	318	318	317
15	326	335	317
16	344	352	340
17	359	357	349
18	350	355	351

TABLE IX.

Antero-Posterior Diameter of Abdomen.

Age	Indian Hindus	Indian Christians	Luso-descendentes
11	..	140	..
12	144	146	140
13	145	152	152
14	147	150	157
15	155	154	160
16	152	159	163
17	161	156	159
18	155	151	160

TABLE X.

Bi-iliac Diameter.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	195	..
12	207	195	215
13	213	215	222
14	214	222	231
15	229	236	237
16	240	245	245
17	244	241	250
18	237	242	246

TABLE XI (*a*).

Circumference of Fore-arm.

(Maximum.)

Age	Indian Hindus		Indian Christians		Luso-descendentes	
	right	left	right	left	right	left
	mm.	mm.	mm.	mm.	mm.	mm.
11	..	..	180	172	..	..
12	185	180	180	177	187	182
13	191	185	190	180	191	187
14	197	193	202	197	205	200
15	216	200	210	204	207	203
16	220	211	213	210	232	226
17	227	225	227	222	233	224
18	224	221	224	220	236	228

TABLE XI (*b*).

Circumference of Fore-arm.

(Minimum.)

Age	Indian Hindus		Indian Christians		Luso-descendentes	
	right	left	right	left	right	left
	mm.	mm.	mm.	mm.	mm.	mm.
11	..	..	117	114	..	..
12	124	122	118	117	121	118
13	124	123	124	122	127	125
14	128	128	133	132	137	134
15	132	132	136	134	135	134
16	137	136	138	136	150	147
17	143	142	145	144	148	143
18	141	141	143	141	150	147

TABLE XII.

Dynamometry.

Age	Indian Hindus arm		Indian Christians arm		Luso-descendentes arm	
	right	left	right	left	right	left
	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.
11	..	..	12,300	10,600	..	..
12	18,800	16,100	16,400	13,300	16,200	15,000
13	19,500	17,200	17,300	16,100	19,300	16,000
14	20,300	17,000	24,000	20,000	20,700	18,500
15	25,500	23,300	27,600	23,300	27,200	24,000
16	30,400	25,700	29,600	26,200	31,600	27,200
17	33,100	28,500	37,300	31,500	41,000	32,500
18	33,900	29,600	34,600	27,000	41,800	34,500

TABLE XIII.

Spirometry.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	L. cl.	L. cl.	L. cl.
11	..	1, 38	..
12	1, 59	1, 67	1, 86
13	2, 1	1, 98	2, 18
14	2, 22	2, 81	2, 39
15	2, 44	2, 71	2, 90
16	2, 76	2, 92	3, 16
17	2, 89	3, 07	3, 49
18	2, 91	3, 28	3, 97

MEDICAL EXAMINATION.

(1) HEREDITY.

No elucidating data were obtained.

(2) PREVIOUS HISTORY.

The incidence of infectious diseases in the 3 groups is as shown below :—

Diseases	Hindus	Indian Christians	Luso-descendentes
Measles ..	73,39 %	77,87 %	72,72
Small-pox ..	4,92 %	2,65 %	1,13 %
Whooping-cough ..	45,81 %	58,85 %	60,22 %
Diphtheria ..	1,47 %	2,21 %	5,68 %
Parotites ..	31,62 %	30,08 %	31,81 %
Typhoid-Para-typhoid infections	28,05 %	24,33 %	14,77 %
Malaria ..	16,74 %	23,00 %	35,22 %

The incidence of Infectious diseases in the total number of the students examined :

Percentages.

Measles ....74·85 %
Small-pox .... 3·28 %
Whooping Cough ....53·96 %
Diphtheria ....2·51 %
Parotites....................30·94 %
Typhoid-Paratyphoid ......
infections ....24·33 %
Malaria ....22·63 %

(3) DIET.

The following were the percentages of different diets :

Vegetarian diet : 3·28. Vegetarian and fish diet : 8·31. Mixed diet : 88·39.

The high percentage of mixed diet is due to the inclusion of Hindu students in this group who, though rarely, eat flesh.

(4) DIGESTIVE SYSTEM.

(*a*) *Examination of the mouth.*—We inspected the roof of the mouth and the condition of teeth. We did not find students with ogival vaults. After carefully examining the teeth we adopted our own classification in which the letter C represents dental caries, the letter F the missing parts, the indices indicate their respective numbers.

Good.—Teeth without signs of caries and well attended to.

Regular.—Teeth with tartar, caries or missing parts not exceeding 2. This group contains the following formulas : C^1, C^2, F^2, C^1F^1.

Bad.—Teeth with caries or missing parts, not exceeding 5 in all.

In this group there are the following formulas :—C^3, C^4, C^5, C^2F^1, C^1F^3, C^2F^2, C^2F^3, C^3F^1, C^3F^2, C^4F^1.

Very bad.—Teeth with pyorrhea, with caries or missing parts exceeding 5 in all.

In this group there are the following formulas :—C^6, C^3F^3, C^4F^2, C^4F^3, C^5F^1, C^5F^2, C^5F^3, C^5F^4, C^6F^1, C^6F^2, C^6F^1, C^6F^2, C^6F^7, C^8F^1.

Based on our classification we found the following condition of teeth : *Good* 38·10 ; *regular* 32·30 ; *bad* 22·63 ; *very bad* 6·97.

Here is the comparative table of the percentages in the 3 groups :—

Groups	Normal teeth	Teeth with caries, missing parts or tartar
Hindus ..	47,78	52,22
Indian Christians ..	34,95	65,05
Luso-descendentes	23,86	76,13
Total examined ..	38,10	61,90

(*b*) *Examination of pharynx and of the tonsils.*— This examination resulted in the following observations : (1) Unilateral hypertrophy of tonsils, (2) Bilateral hypertrophy of tonsils, (3) Adenoids, (4) Other diseases of pharynx.

The following are the percentages of each group :

Groups	Hypertrophy of the tonsils		Ade-noid vege-tations	Other diseases of Rhino-Pharynx
	Unilateral	Bilateral		
Hindus ..	19,21	12,80	5,91	..
Indian Christians ..	20,79	11,06	7,52	..
Luso scendentes	30,68	22,72	5,68	1,13

Here are the percentages in the total number examined :

Hypertrophy of the tonsils (Unilateral) 21,95%
Hypertrophy of the tonsils (Bilateral) 13,34%
Adenoid vegetations 6,57%
Other diseases 0,19%

(*c*) *Examination of the Intestines.*—We aimed at finding out the incidence of constipation and diarrhœa. Here are the results :

Groups	Normal	Consti-pation	Diarrhœa
Hindus ..	98,57	1,47	..
Indian Christians ..	93,36	6,63	..
Luso-descendentes	90,90	9,09	..

(*d*) *Hernia Regions.*—We found only one student, Luso-descendente, with inguinal hernia.

(5) RESPIRATORY SYSTEM.

Beyond the thoracic measurements nothing noteworthy of mention.

(6) CIRCULATORY SYSTEM.

(*a*) *Examination of the pulse.*—This examination was conducted with the student lying in bed.

The percentage of tachicardia was of 18·71 in Hindus, 22·56 in Indian Christians and 21·59 in Luso-descendentes, the percentage in relation to the total number examined being 20·88. The percentage of bradi-cardias was 3·09.

(*b*) *Heart examination*.—This examination consisted of auscultation and determination by palpation and percussion the position of the apex. The students were observed in both standing and dorsal positions. The following was the percentage of abnormalities (murmurs, extra-systoles, hypertrophies) found : *Hindus*, 13·3 : *Indian Christians*, 5·79 ; *Luso-descendentes*, 5·68. In our report we discussed and analysed the cause of these hypertrophies which can be generally attributed to (1) Athletic exercises and to sports without previous physical training. (2) Excessive cycling. (3) The staircase of the Liceu of 140 steps which the students must climb everyday. (4) Intellectual overwork. (5) Infectious diseases. (Typhoid fever and rheumatism.)

(*c*) *Efficiency of the Heart.*—The test which we made use of was the step-proof of Lian used with brilliant success in French methods. We found 4 Indian Christian students and 1 Hindu with fair cardiac sufficiency.

(*d*) *Blood Pressure.*—We determined the blood pressure of all the students by Boulitte-Korotkow spygmanometer. The blood pressure is, in general, higher in Hindus. The normal range in Indian Christians and Luso-descendentes, of 12 to 20 years, is of 10 to 12 cm. Hg. to P. mx. and 6 to 8 cm. Hg. P mn. while in Hindus it oscillates between 11 to 13 P. mx. and 7 to 9 P.mn. The predominant differences of the pressures are 4 to 5 cm. Hg. in all three groups :—

(7) GENITO-URINARY SYSTEM.

The following is the table of the percentages of general diseases.

Groups	Varico-celes	Hydro-celes	Orchitis
Hindus ..	1,97	0,98	1,96
Indian Christians ..	3,54	0,44	1,32
Luso-descendentes	4,54	1,13	1,13
Total examined ..	3,09	0,77	1,54

We noted also some congenital malformations : two cases of undescended testicles in the inguinal canal ; one case of the testicular atrophy : one case of triorchidia ; two cases of infantile penis with proeminent pubis and rudimentary labia majora.

(8) SKIN DISEASES.

The following was the distribution of skin diseases : Hindus, 8·86. Indian Christians, 7·08. Luso-descendentes, 2·27. In relation to the total number examined : Sane, 93·03, Skin diseases, 6·93.

(9) LYMPHATIC SYSTEM.

The table with the distribution of ganglionary hypertrophy is the following :—

Groups	Normal	Cervical	Epitroclears	Inguinal
Hindus ..	38,42	17,22	6,40	11,33
Indian Christians ..	26,10	23,89	2,21	12,83
Luso-descendentes	32,95	26,13	3,40	6,81
Total examined ..	32,10	21,66	4,06	11,21

Groups	Cervical & Epitroclears	Cervical & Inguinal	Epitroclears & Inguinal	Cervical Epitroclears & Inguinal
Hindus ..	4,43	12,80	3,44	5,91
Indian Christians ..	1,77	27,43	1,32	4,42
Luso-descendentes	3,40	14,77	3,40	9,09
Total examined ..	3,09	19,53	2,51	5,80

(10) SKELETON.

(*a*) *Deviation of Vertebral Column.*—The Table of the distribution of the percentages is the following :—

Groups	Normal	Kyphosis	Scoliosis	Lordosis
Hindus ..	52,21	22,16	25,61	..
Indian Christians ..	51,32	23,89	24,33	0,44
Luso-descendentes	53,40	20,45	26,13	..
Total examined ..	52,03	22,44	25,14	0,19

(*b*) *Deformities of the Bones.*—The most common deformities we found were rachitic thorax. Its distribution was : Hindus 5·91; Indian Christians 11·50; And Luso-descendentes 7·95. Total examined 8·70.

(*c*) *Anomalies.*—We registered an interesting case of second stage of hectrodactillea with the absence of metacarpals and fingers.

(11) EYES.

The examination of sight was made by the Vicker's optometric scale. Here is the Table :—

Groups	Short-sighted	Without correction of sight
Hindus ..	24,77	66,07
Indian Christians ..	16,74	79,44
Luso-descendentes	18,18	68,75
Total examined ..	20,05	70,74

(12) EARS.

The examination of auditory acuteness was made with a "Longines" clock. Considering that the majority of students hear the tic-tac of the clock at a distance of 45 to 70 cms. and taking this ear as a normal one, we established the following classification :

				cms.
Excellent: ear,	hearing	at a dist.	of	100 to 75
Normal	,,	,,	,,	70 to 45
Weak	,,	,,	,,	40 to 15
Bad	,,	,,	,,	10 to 0

The table with the distribution of the percentages according to our classification is the following :—

Hearing Capacity	Hindus		Indian Christians		Luso-descendentes	
	ear		ear		ear	
	right	left	right	left	right	left
Excellent	13,79	12,80	14,16	15,48	25,00	22,73
Normal	48,28	47,79	48,67	51,78	52,28	56,82
Weak	35,46	35,96	33,62	30,97	19,32	20,45
Bad	2,47	3,45	3,55	1,77	3,40	0

Research Notes.

The Longest Convex Curve Described about a Convex Polygon.

MAYER (*Crelle's Journal*, Bd. 174, Heft 3, pp. 125–128) has solved this interesting problem by means of a very simple analysis. First of all, for a triangle, a quadrilateral, and for all polygons for which the sum of any two consecutive angles is $< \pi$, there are convex curves circumscribing them of as great a length as we like. Therefore, the problem will be of interest for all polygons which do not belong to the above category; *i.e.*, if $p_1 p_2 \ldots p_n p_1$ is the polygon $\overrightarrow{p_i + 1 p_i}$ and $\overrightarrow{p_{i-2}\, p_{i-1}}$ should meet when they are produced in the way that is indicated; let the triangle that is obtained by adding $p_{i-1}\, p_i$ as a side be denoted by D_i. If K is the polygon, then it is obvious that the perimeter of every circumscribed convex curve is $<$ that of the polygon (not convex of course) $K + \Sigma D_i$. Hence, the existence of the curve follows. (By means of a procedure analogous to the proofs of the classic results in the theory of normal family of functions.) By means of a nice elementary geometrical analysis he has proved that the convex curve is found among the polygons $M = K + \Sigma \epsilon_i D_i$ ($\epsilon_i = 0$ or 1). It is obvious that the following conditions should be satisfied (1) $\epsilon_i = 1$, then $\epsilon_{i-1} = \epsilon_{i+1} = 0$. (2) If $\epsilon_{i-1} = \epsilon_{i+1} = 0$ then $\epsilon_i = 1$; so that the number of different polygons among which we have to search for the longest is appreciably less than 2^n. If g (n) is their number then it is easy to show that $g(n) = g(n-2) + g(n-3)$ (formally put $g(-1) = -1$, $g(0) = 3$, $g(1) = 0$.

K. V. I.

Class-Number Relations of Binary Quadratic Forms in Quadratic Fields.

LUBELSKI (*Crelle's Jour.*, Bd. 174, Heft 3, pp. 160–184) has found out the number of classes of quadratic forms whose coefficients belong to an imaginary quadratic field $K(\sqrt{-q})$, (we assume that $q \geqslant 3$, throughout. He has also found out the corresponding relations for the Gaussian field) the number of ideal classes of which are *odd*. If H is the number of classes of quadratic forms with integral coefficients out of $K(\sqrt{-q})$ and discriminant $D = 4D'$[D' *quadrat-frei* in $K(\sqrt{-q})$,] and h and h' are the number of classes of quadratic forms with discriminant D and $-qD$, respectively then $H = hh'$ or $2hh'$ according as $x^2 - Dy^2 = -1$ is solvable in natural numbers are not. In the first part of his work he has solved the problem for quadratic forms whose coefficients are integral ideals of $K(\sqrt{-q})$. The results in this case are mostly analogous to the classical results connecting ideal classes of $K(\sqrt{-q})$ and the rational quadratic forms with discriminant $-q$; we have to consider a relative quadratic field and ideal classes relative to $K(\sqrt{-q})$. Signifying as a real ideal class, a class in which the quadratic forms with integral numbers out of $K(-\sqrt{q})$ as coefficients, it is interesting to note that Lubelski has given examples of relative fields in which all the classes of quadratic forms with integral ideal coefficients are equivalent to the real classes alone.

In the second part, he proves the final result by means of a series of lemmas. A summary of the proof is the following. (Note that $q \geqslant 3$ and that the number of ideal class is assumed to be *odd*.) He has first of all considered quadratic forms of two types—the first type consisting of all quadratic forms of the form $ax^2 + bxy + cy^2$ and the second of the form $ax^2 + b\sqrt{-q}\,xy + cy^2$. (Discriminant D, a, b and c natural integrals.) He has shown that equivalence of the quadratic forms of the first type in the rational as well as in $K(\sqrt{-q})$ is the same. [This theorem is true even if the class-number of $K(\sqrt{-q}]$ is *even*); and if a form of the first type is transformable into a form of the second type in $K(\sqrt{-q})$, then the form should be equivalent to an *ambig* form and conversely. Next, he has shown that every quadratic form with rational coefficient and discriminant $-Dq$ can be transformed by means of a suitable transformation to one of the second type; and that the product of two forms of the first or second types are equivalent to forms belonging to the same type. By means of a lemma he has connected the equivalence of two forms of the second type with one of the first type with the reduction of the corresponding forms with discriminant $-Dq$ to the form $ax^2 + aq\rho xy + cy^2$ [$\rho = 0$ or 1]. Afterwards he has determined the number of non-equivalent forms which are products of a form of the first type and another of the second type in terms of h, h' and v, the odd

prime factors of D′. Next he has defined (analogous to the rational case) the characters of a class of quadratic forms; and he has determined the necessary and sufficient conditions in order that a quadratic form with coefficients out of K $(\sqrt{-q})$ is capable of representing natural numbers; first of all, it should be a product of two forms of the first and second types respectively. The second condition depends on characters (Norm-residue symbols of Hilbert). By means of these intermediate theorems the exact number of classes of quadratic forms, mentioned in the beginning is determined.

K. V. I.

An Apparent Failure of the Photon Theory of Scattering.

IT is well known that A. H. Compton has explained the scattering of X-Rays by free electrons, assuming that the collision between an X-Ray photon and an electron would be governed by the principles of conservation of energy and momentum. One of the consequences of this photon theory of scattering is that the recoil electron and the scattered photon should appear at the same instant. R. S. Shankland (*Phys. Rev.*, **49**, 8) has examined whether this coincidence is true in the region of incident γ-ray quanta. He employed specially constructed Geiger-Müller tubes in two directions for the recoil electrons and the scattered photons respectively, such that the angle between the directions is given by the photon theory of scattering. He also chose the directions of the counters at different angles. Providing necessary arrangements to record coincident discharges in the electron and the photon counters and employing γ-rays from radium-C, he found that the observed coincidences are quite small compared with the expected coincidences and also that the observed coincidences are rather due to the scattered γ-ray quanta entering the electron counters and discharging secondary electrons from the counters. Thus Shankland opines that there are no genuine coincident discharges at all. In reviewing Shankland's results, Dirac (*Nature*, **136**, 298) seems to think that they demand a revision of the theory of the interaction between matter and radiation without perhaps the principles of the conservation of energy and momentum.

N. S. N.

Raman Effect in Chemical Dynamics.

IN the March number of *Physica*, p. 154, W. F. Buzhold and L. S. Ornstein present an interesting report of the applications of Raman spectra methods to a study of chemical reactions, such as the oxidation of transformer oils and the photo-chemical chlorination of chloroform to carbon tetrachloride. A calibration curve for the latter was drawn up by plotting the intensities of the carbon tetrachloride Raman lines against the amount of carbon tetrachloride present in a mixture of chloroform and carbon tetrachloride. The graph was a straight line. The experimental results are discussed in great detail in relation to the dynamics of the reaction. It is suggested that highly unstable chain products could be detected by Raman spectra, as unlike the ultra-violet and infra-red absorption spectra, the former is an integrating effect.

M. A. G. RAU.

New Radioactive Transformations produced by Bombardment of Uranium by Neutrons.

THE discovery of trans-uranic elements by Fermi and his co-workers and its confirmation by Meitner have already been noticed in *Curr. Sci.*, 1935, **3**, 376. Meitner and Hahn have recently studied the various products obtained by bombarding uranium with neutrons and by comparing the activities produced by fast neutrons and slow neutrons (slowed down by passage through paraffin) they have reached interesting conclusions regarding the processes that occur (*Naturwiss.*, 1936, **24**, 158). The radioactive properties of elements 93 (Eka-Re), 94 (Eka-Os) and 95 (Eka-Ir) have been thus determined. The processes envisaged as leading to the production of these elements are the following:

(1) $U^{238} + n \rightarrow Th^{235} + \alpha$; $Th^{235} \xrightarrow{\beta} Pa^{235} \xrightarrow{\beta} U^{235} \xrightarrow{\beta} \text{Eka-Re}^{235} \xrightarrow{\beta}$?

(2) $U^{238} + n \rightarrow U^{237} + 2n$; $U^{237} \xrightarrow{\beta} \text{Eka-Re}^{237} \xrightarrow{\beta} \text{Eka-Os}^{237} \xrightarrow{\beta} \text{Eka-Ir}^{237}$?

(3) $U^{238} + n \rightarrow U^{239}$; $U^{239} \xrightarrow{\beta} \text{Eka-Re}^{239} \xrightarrow{\beta} \text{Eka-Os}^{239} \xrightarrow{\beta} \text{Eka-Ir}^{239}$?

The following table summarising their results is taken from their paper.

Atom	Half-value period	Produced by
Th^{235}	4 min.	Slow neutrons
Pa^{235}	Very short ?	Slow ,,
U^{235}	24 ± 2 min.	Slow ,,
U^{237}	40 sec.	Fast ,,
U^{239}	10 sec.	Better by slow ,,
Eka-Re^{237}	16 ± 1 min.	Fast ,,
Eka-Re^{239}	$2 \cdot 2 \pm 0 \cdot 2$ min.	Better by slow ,,
(Eka-Os^{237}) ?	12 hrs.	Fast ,, ?
Eka-Os^{239}	59 ± 2 min.	Better by slow ,,
(Eka-Ir^{239}) ?	3 days	?

T. S. S.

On the Structure of Cosmic Radiation.

THE nature of the radiation which gives rise to the showers observed by Blackett and Occhialini has been a somewhat disputed question. The primary cosmic radiation is now accepted to be corpuscular and is denoted by the letter A in Geiger's notation. The shower-producing radiation seems not directly to produce ionisation and may be some kind of γ-radiation. Whether it is a B-radiation, *i.e.*, one produced directly by the primary A-radiation, has not been so far settled. Now R. Hilgert and W. Bothe (*Zs. f. Physik*, 1936, **99**, 353) describe experiments which show that the shower-producing radiation is a B-radiation produced in the matter near the earth. Besides this they show that this B-radiation itself comes in the form of bundles so that it is now clear why it should produce showers. The experimental method was to count the number of double coincidences recorded by two counters kept side by side when a lead sheet was placed above one or the other of them and when lead sheets were placed over neither or both. The radiation was allowed to fall on the lead sheets once directly and once after passage through a carbon filter. It was found that when the radiation had first passed through the carbon, the increase in the number of coincidences observed with lead sheets on both counters was much larger than the sum of the increases observed when one or the other counter had a lead sheet over it. When the radiation fell directly, however, the increase in the number of coincidences due to a lead sheet on either counter was much larger than before but the increase when lead sheets were placed over both counters was simply the sum of the increases due to each sheet separately. These results are explained by assuming that the shower-producing radiation must have started in bundles from a distance corresponding to its range. When the carbon filter was employed the bundles should have come from somewhere near the filter and thus fallen in almost parallel paths on the two lead sheets simultaneously producing showers therein. When the radiation came directly, however, it should have started at a much larger distance corresponding to the range in air, so that the bundles would have diverged sufficiently not to fall simultaneously on the two lead sheets. This explanation was further confirmed by observing quadruple coincidences with four counters, one pair of which was above the other.

T. S. S.

Atomic Weight of Gallium.

LUNDELL AND HOFFMAN (*J. Research of the National Bureau of Standards*, October 1935), starting with a quantity of metallic gallium, previously prepared by one of the authors and the purity of which was estimated to be at least 99·999 per cent., have determined its atomic weight.

Known quantities of this very pure metal were dissolved and converted into the hydroxide, sulphate, and the nitrate, these salts being subsequently ignited to the oxide and weighed. This procedure enabled the calculation of the atomic weight of gallium with direct reference to that of oxygen.

The suitability of metallic gallium as well as that of its oxide for work of this type was established after a careful exploration of the sources of error which were likely to occur, and these included, (*a*) occluded gas in the metallic gallium employed, (*b*) oxide film on the metal, (*c*) presence of minute traces of chlorides in the metal, (*d*) constancy in weight of gallic oxide after ignition and its hygroscopicity, (*e*) occluded gas in the

ignited gallic oxide, and (*f*) constancy in weight of platinum crucibles when heated for long periods at 1200–1300° C.

The averages of the three sets of values obtained from the experiments with the hydroxide, nitrate and the sulphate were respectively $69 \cdot 73_7$, $69 \cdot 73_5$, and $69 \cdot 73_7$. The rounded value $69 \cdot 74$ is therefore put forward for the atomic weight of gallium.

K. R. K.

Vitamin B_6.

IMPORTANT studies on that part of the Vitamin B_2 complex which is responsible for the cure of the specific dermatitis developed by young rats fed on Vitamin B-free diet supplemented by purified Vitamin B_1 and lactoflavin, have been reported from the Cambridge University, by Birch and György (*Biochem. J.*, 1936, **30**, 304). In fish muscle and wheat germ this Vitamin appears to be attached to a protein as a prosthetic group and for quantitative extraction, it is necessary to autolyse the tissue digest with papain. The Vitamin is not precipitated by salts of lead, mercury or silver, or by picric acid, but is precipitated by phosphotungstic acid; it is soluble in ethyl alcohol but is not extracted from a concentrated watery solution by acetone, amylalcohol or ether. Fuller's earth adsorbs the Vitamin from acid solutions, and during electro-dialysis it migrates towards the cathode. Vitamin B_6 appears therefore to be of a basic nature, and, from the fact that it can be inactivated by benzoylation but not by the action of nitrous acid, it is suggested that it does not contain a primary amino-group, but that it possibly possesses a hydroxyl group.

Hastening Germination of Acacia Seeds by Soaking in Boiling Water.

EXPERIMENTS reported in the *Agricultural Gazette of New South Wales*, **47**, Part I, show that for effective and rapid germination in the case of certain acacias (*Acacia Baileyana*, *Acacia aneura*, and *Acacia elata*) soaking in boiling water is found very satisfactory. In the case of the first it was found that even six years old seed will not germinate unless the hard outer coat is softened by intense heat. Untreated seed was compared with (1) seed soaked in cold water for thirty minutes, (2) seed soaked in cold water and the water then brought to the boiling point, (3) water brought to the boiling point and seed immersed and allowed to remain for ten minutes with the heat turned off, and (4) seed placed in boiling water and boiling continued for ten minutes. It was found that the germination in the last three treatments was from 80 to 90 per cent. while the cold water soaking and the control gave less than 10 per cent. It also made very little difference if the seed was only two years old or was six years old.

Cement Concrete for Grain Storage Bins.

QUITE a useful application of cement concrete construction in agriculture is its use for the construction of underground grain bins or granaries. (N. C. Mehta in the *Agriculture and Livestock in India*, **6**, Part I.) The very primitive but, at the same time, very general practice of storing grains like *ragi* and *jola* in underground straw-lined pits common in Mysore has its counterpart in the storage of wheat in Upper India. Here, however, the storage is on a very large scale being adopted by the important and large grain merchants for the holding up of grain intended for sale; it is not the small domestic affair such as prevails in Mysore. Both are however subject to the same drawbacks in regard to damage and deterioration and especially where the soil is unsuitable or the season excessively wet. A loss of some four lakhs of rupees is reported during the very rainy year 1933 in the grain stores of Muzafarnagar, while the danger of the damaged grain getting into the hands of poor people and being used as food was an even more serious matter. The Concrete Association of India has taken up the matter and already some 200 cement storage cisterns are said to have been constructed for the grain merchants of that large trade centre. The cost per 100 cubic feet of storage space is put down at about Rs. 33, with cement at Rs. 52–8–0 per ton, sand and single at Rs. 20 per ton each. While for the grain trade the regular well-equipped grain elevators usual in other countries will be the most suitable type of large-scale storage bins designed to meet modern conditions of transport, these underground concrete cisterns are certainly a great improvement and will suit the needs of the smaller individual trader. For the ordinary cultivator too it is a desirable improvement to adopt and does not appear too costly.

Studies on the Nature of Disease Resistance in Cereals.

APPLICATION of nitrogenous fertilisers has been recognised to increase severity of rust attack in cereals. It is maintained by Gassner and his co-workers in Germany that an increased supply of N, leads to an increase in the availability of protein in the plant, conducive to rust development. Johnson and Johnnson (*Canadian J. Res.*, 1935, **13**, 355) analysed mature and immature tissues of the wheat plant to ascertain if the latter are richer in organic N than the former, as it is recognised that the immature tissues are more susceptible to stem rust than the full-grown tissues. Analyses of N in six varieties showed that the N-content was greater in the mature tissues than in the immature ones. The greater susceptibility of the younger leaves cannot be attributed to a higher organic N-content, unless it is assumed that the N is present in a more utilisable form than that of the older leaves.

In a previous paper, the authors showed that the young tissues were richer in sugars than the older ones (*Canadian J. Res.*, 1934, **11**). It is concluded that the resistance of the mature tissues to rust cannot be explained on a purely nutritional basis.

M. J. N.

The Virus of Sugarcane Mosaic.

INTERESTING studies of the Sugarcane Mosaic Virus both in the laboratory and in the field are reported in the *Indian Journal of Agricultural Science*, **5**, Part VI. A study of the physical properties by S. A. Rafay brings out that (1) like the crinkle mosaic of the potato the cane mosaic virus tolerates a 1 in 10 dilution and that by a dilution of 1 in 100 and above the virus entirely loses its potency; (2) it loses its potency in two hours in contrast with the spotted wilt of tomato which does so in six hours and the tomato mosaic virus which remains viable for years; (3) no infection is obtained with a filter paper filtrate or the Chamberlain candle filtrate, while the green residue left on the filter paper is infective; and (4) it is one of the most sensitive of viruses and shows the least resistance to chemical reagents; thus copper sulphate 1 in 1500, hydrochloric acid 1 in 1000, nitric acid 1 in 800, mercuric chloride 1 in 1000, sodium chloride 1 in 25, hydrogen peroxide 1 in 25, and formalin 1 in 50, all inactivated the virus. It is noted with interest that an oxidising agent (hydrogen peroxide, Merck's) had no effect on the virus in 1 to 50 parts, while Johnson (1926) found even a resistant type like the tobacco mosaic virus to be sensitive to the inactivating effect of oxygen.

Field studies in the Punjab by J. C. Luthra and Abdus Sattar covering a period of three to six years show the following, *viz.*, (1) only the primary symptoms, *i.e.*, mottling of leaves occur in the Punjab and that the secondary symptoms, *i.e.*, the dwarfing of the canes, etc., are not observed; (2) the amount of infection on any particular variety varies from place to place and that some varieties are more infected than others, observations having been made on about 45 varieties nearly all of them cotypes; (3) the canes show the first symptoms about a month and a half after planting and that the infection goes on increasing till October; (4) in the variety Co. 223 (during three years' observations) no decrease in the yield of cane, juice or gur occurred as the result of mosaic nor was there a deterioration in the quality of the juice; and (5) that roguing can keep the disease within limits in those varieties only which are not very susceptible to mosaic.

Detergent Action of Soluble Silicates.

SILICATE solutions have been used as cleansing agents in a variety of ways, and the advantages of employing soluble silicates is of great importance to those interested in detergent technique. The different aspects of this problem has been studied by Vail in a recent paper (*Ind. Eng. Chem.*, 1936. **28**, 294). The effect on the pH values of solutions by variation of the $Na_2O : SiO_2$ ratio, as also by changes in concentration, have been investigated. The advantage of employing sodium silicate for cleaning metallic surfaces at higher temperatures, without appreciable corrosion, has been pointed out. So far as bactericidal effect is concerned, silicate solutions are more effective than soaps. The silicate solutions are better deflocculating agents than soaps and their wetting power is also decidedly better. They are good emulsifying agents when mixed with soaps and are technically employed in the preparation of asphalt

emulsions. It is therefore clear that sodium silicate is no longer thought of as an adulterant to soap, but as a useful adjunct in improving its properties.

M. P. V.

The Skull of the Therocephalia.

A MINUTE study of the cranial characters of the mammal-like reptiles of the group Therocephalia forms the subject of an important paper by R. Broom (*Phil. Trans. Roy. Soc., Lond.*, B, March 1936, **226**, No. 529, 1–42). The study has been made by means of sections of these fossil forms all of which belong to South African Permian beds. The importance of this group cannot be overestimated as it is highly probable that the "line of mammalian descent passed through some members of the Therocephalia". The skull, which is remarkably like that of a mammal in structure, includes factors like heterodonty and a temporal arch formed of the jugal and the squamosal. But the differences are none the less striking. The place of the single median vomer of the mammal is taken in the Therocephalids by a pair of bones situated well behind and probably homologous with the dumb-bell-shaped bone of Ornithorhynchus. The quadrate is still a very pronounced bone and the lower jaw is still a compound structure.

Geological Aspects of Underground Water-supply.

IN discussing the underground water-supply of England in a series of three Cantor Lectures delivered at the Royal Society of Arts (*Journal of the Royal Society of Arts*, Feb. 1936, **84**), Dr. Bernard Smith has shown that this water-supply is largely dependent upon rainfall, evaporation and percolation. The large quantity of water which percolates downwards is utilised partly by plants and mineral substances; but the greater portion is stored up under suitable conditions in rocks. The availability of this water depends upon several factors like porosity, perviousness and joints. Several rocks, such as coarse sandstone, clay and chalk, are highly porous and hence contain a large supply of water. The igneous rocks have an average porosity of only 1 to 2%, but yet such of them as are highly jointed and fissured like the Indian basalts contain a steady supply of water as shown by Dr. Fox.

With the help of sketches, Dr. Bernard Smith has also referred to the development of Artesian wells and the factors which control the water-supply in them. The chief water-bearing strata of England are the Carboniferous limestone, millstone grit, coal measures, inferior oolites and great oolites. The geological factors which control the underground water-supply are faults, flexures and missing formations. It is thus obvious that the underground water supply is beset with numerous difficulties and usually it requires the co-ordination of the geologists and the water supply engineers to locate suitable spots for successful operation.

Some Alkaline Rocks of the Shansi Area, N. China.

AT a time when the problem of the genesis of the alkaline rocks is being widely discussed, it is interesting to observe that the Nystrom Institute for Scientific Research in China has published (E. T. Nystrom, *Bull. Geological Institute of the University of Upsala*, **22**) a very comprehensive account of the alkaline rocks of Shansi. This area is equal in size to England and Scotland combined, and the alkaline rocks were first discovered here by E. T. Nystrom in 1910. This part of North China has been divided into three important tectonic divisions. In the central portion, where the trend lines of the tectonic system meet, are developed a series of dislocations which have resulted in the eruption of the alkaline rocks.

The alkaline rocks themselves are distributed in three distinct regions and they occur mostly as laccoliths or stocks either in the archæns or in the later sedimentary rocks, such as shales and limestones. In the latter case the sediments have been metamorphosed, accompanied by an abundant development of calc-silicates. In some cases huge blocks of limestones have been caught up by the intruding magma and they have been burnt and rendered powdery. According to the author, the intrusions seem to have taken place in the mid-tertiary period.

There is a striking similarity in the sequence of eruptions in the different localities,

and the parent magma seems to be of an akeritic composition as in Oslo (Christiania) and Hobart (Tasmania). This akeritic magma shows evidences of differentiation in three distinct branches—granitic, syenitic and dioritic. It is evident that by the elimination of the granitic differentiate a large quantity of the silica content has been removed ; and there has been a considerable impoverishment of plagioclase and femic minerals by the dioritic differentiate. The residual syenitic magma has been the source for the evolution of the more alkaline types, such as nordmarkite, nepheline syenite, leucite syenite, tinguaite, etc. The paper contains a large number of analyses, charts, figures and calculations of great petrographic value. This is the first time that such a detailed presentation of the alkaline rocks of the Shansi area is made and it is bound to be of great interest to all igneous petrologists.

Progress of Science in India.

IN the course of his address welcoming the delegates to the Joint Session of the Scientific Societies held at Bangalore (10th-14th April), Sir C.V. Raman, KT., F.R.S., N.L., pointed to three ideals which should guide research workers to secure for India a prominent place in the scientific map of the world. A fastidious attention to a high standard of quality in scientific research constitutes the first ideal ; weeds shall have no place in the garden of science and, to ensure a steady and wholesome growth and development, the weeds must be scrupulously kept out. The second ideal is to recognise the essential unity of knowledge. Science should not be conceived in terms of water-tight compartments even as a matter of administrative expediency. Administrative separatism leads to intellectual separatism and eliminates that essential factor which makes for intellectual co-operation among scientists pursuing different branches of knowledge, a co-operation which is necessary for the fruitful progress of science. Many of the outstanding discoveries have been made in laboratories which have stood for such an ideal, and where several scientific subjects are studied in close juxtaposition. To cite one instance, the discovery by von Laue, of the diffraction of X-rays, was made possible in the favourable environment provided by the Munich Laboratory where such stalwarts like Prof. Sommerfeld, the eminent mathematical physicist, and Prof. Granz, the famous mineralogist and crystallographer, were working. Lastly, it is necessary to recognise the leadership which mathematical thought possesses in the progress of science. It is utterly futile to evaluate science on the gold standard. There is an amazing contempt for scientific work which does not bring an immediate monetary return. " With all the emphasis I can command, I sound a note of warning of the dangers of this attitude," said Sir C. V. Raman. " The deeper and fundamental aspects of science appeal to but a few who possess a disciplined attitude of mind. No progress can be achieved in any branch of science if we lose our respect for, or withhold support to, the fundamental sciences of Mathematics and Philosophy; the more we neglect these the less we advance. " Research, not founded on fundamental mathematical concepts, is like food devoid of vitamin, that entity which makes all the difference between calories and nutriment.

Stratosphere Flight in the Balloon "Explorer".*

GAY-LUSSAC was probably the first scientist to go up in 1804 into the earth's atmosphere in a hydrogen-filled balloon to obtain accurate knowledge of it *in situ*. Since then there have been, at various times, a number of balloon flights; some have been successful, but others have ended in tragedy and death.

But the spectacular and successful flight in 1931 of Auguste Piccard, the pioneer of balloon ascensions, in a sealed metal gondola, became the forerunner of the subsequent series of balloon flights in Russia, Belgium and the U.S.A.

The publication under review gives, in a series of articles, the details of the flight into the stratosphere of the giant balloon *Explorer* on 28th July, 1934. This expedition was organised jointly by the National Geographic Society and the Army Air Corps of the U.S.A. and is a wonderful example of co-operative effort in the cause of science by a large number of scientists and private and public organisations and individuals.

The object was to collect accurate information about the variations with height of temperature, pressure and humidity, wind velocity, compositions of air, the ozone layer, the directional intensity of cosmic rays, altitude measurements, colour of sky, etc.

The large number and variety of specially designed, highly intricate instruments and associated equipment were all arranged suitably in a sealed magnesium alloy (Dowmetal) spherical gondola, 9 feet in diameter, till it was really a densely packed, multi-purpose, floating laboratory with its own radio telephone (transmitting and receiving) equipment for continuous communication with the earth below.

To lift this great weight with three men inside to a height of some 75,000 feet above sea, the balloon was designed to have the gigantic volume of about 3,000,000 cubic feet, standing some 300 feet when partially inflated and changing into a spherical shape of 180 feet diameter high up. The covering was of rubberised cotton fabric and entirely without a single stitch over its whole area of over 11,000 square yards.

The various beautifully illustrated technical papers on the design, construction and operation of the balloon, gondola, cosmic ray apparatus, spectrographs, barometers, cameras, etc., by outstanding men like Millikan, Swann, Briggs and others are most interesting and instructive to read even for the lay reader. Every detail of every piece of apparatus and mechanism was worked out with meticulous care and precision to secure maximum safety for the fliers and the balloon, and the smooth and efficient working of everything over the extremely varying physical conditions during the flight.

Despite all this, and of the fact that the three fliers were outstanding airmen, the great balloon started to give way at 11 miles above earth and ended in disaster for the balloon, the gondola and all the many beautiful apparatus inside it. Only the fliers saved themselves by jumping out with their parachutes.

It is impossible to withhold admiration for the great composure and utter disregard of personal safety shown by the heroic fliers over the prolonged period of over two hours from the moment when they first noticed the rent in the balloon fabric when at a height of 57,000 feet. Fully realising the extreme and instantaneous hazard to life at any moment, they attended to their respective duties throughout with a cool courage and devotion to work that are beyond praise.

Highly interesting as are the technical articles, no reader, lay or learned, can read unmoved the graphic story of the flight by Captain Stevens and the shorter report by Major Kepner. The numerous excellent photographs help to give a strikingly vivid picture of the various stages of the flight.

Not the least remarkable feature of the expedition was the part played by radio. From the beginning to the last moment when the fliers jumped out of the detached gondola hurling down to the earth, there was perfect two-way radio telephone communication between the gondola and the earth. The millions of listeners throughout the United States followed from minute to minute the thrilling events of the flight and the last minute escape of the airmen.

Of the results of the expedition, the publication does not say very much as, with the gondola, all the valuable records with the exception of a few were destroyed.

All the observations show that the *Explorer* reached a maximum altitude of a little over 62,000 feet. Altitudes by the barometric formula and the vertical camera photographs agree with each other remarkably well (page 23). Wind velocity varied from a value of 70 miles per hour at 42,000 feet blowing from north-west to 28 miles at 50,310 feet and in the same direction; but at about 60,000 feet, it dropped to 10 miles per hour and in the opposite direction, blowing from south-east.

Temperature fell with height in proportion to the logarithm of the pressure upto about 150 mm. of mercury (page 21); with a reduced rate of fall, a minimum temperature of $-62°$ C. was reached at the height corresponding to 75 mm. of mercury. Further up, a rise in temperature occurred.

Cosmic rays increased in intensity with height and with inclination to the horizontal (pages 12, 13, 423).

Altogether a very readable account of an excellently planned daring enterprise which deserved better luck. It will be with no small interest that the report of the recent successful flight of *Explorer II* will be expected.

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* The National Geographic Society—*U. S. Army Air Corps Stratospheric Flight of 1934 in the Balloon 'Explorer'*; Published by the National Geographic Society, 1935.

Band Spectra and Valency.*

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ELECTRONIC CONFIGURATIONS.

THE vibrational analysis of the band system of a diatomic molecule gives the vibrational frequency ω and the factor of anharmonicity ωx and according to the formula $D = \frac{\omega^2}{4\omega x}$ the dissociation energy D of each of the two electronic states involved. It is mostly possible also, to obtain an idea as to the character of these terms, *e.g.*, from considerations of the emitter and the number of heads each individual band possesses. The internuclear distance r_0 can also be estimated by certain empirical formulæ and this as well as the character of the terms can be definitely confirmed by the detailed rotational analysis of the bands.

In analogy with the spectra of atoms we distinguish these terms by their multiplicity and by the value of a quantum number, which represents the total orbital angular momentum along the nuclear axis of the molecule. Thus we get Σ, Π, Δ, etc., if this quantum number $\Lambda = 0, 1, 2$, etc. The multiplicity is indicated by a superscript thus $^1\Sigma$, $^2\Sigma$, $^3\Sigma$, etc., which means that the spin quantum number S has the values 0, $\frac{1}{2}$, etc., the multiplicity (number of sub-levels) being given by $2S + 1$.

This description is not complete, but sufficient for the purpose of the present subject, which is the electronic configuration of the molecule. There are two ways to construct the wavefunction of a molecule. The first method has been developed mainly by Heitler, London, Slater, and Pauling, and is therefore known as the H.L.S.P method.[1] This method constructs the wavefunction of the molecule from those of the separated atoms or their valence electrons and accordingly arrives at the character of the molecular electronic term from considerations of the constituting atomic terms. The second method, originated by Lennard-Jones and developed by Herzberg, Hund, and Mulliken, is called the method of molecular orbitals and starts from the very beginning with the completed molecule, *i.e.*, with the atoms at their proper internuclear distance and constructs the wavefunction of the molecule from those of its constituent electrons. The first method naturally is better suited for the description of the molecule at large internuclear distances, while the second one is so at smaller distances. Both of these have their own advantages; thus the H.L.S.P. method appears to be superior, as far as questions of energy are involved, whereas the orbital method is more suited to the description of the electronic configuration and term scheme of the molecule. We shall therefore take up the latter view-point and base the following remarks on the method of molecular orbitals.

Accordingly, we start with the system of the two positively charged nuclei at a fixed distance and introduce into the resulting field the electrons of the molecule individually one after the other. A molecule is distinguished from an atom because its field possesses a favoured direction; this corresponds to the behaviour of an atom in a strong electric field and the quantum numbers of the electrons therefore are the same as those of the Stark effect. Each single electron is characterised by an axial quantum number λ, which shows, how much each electron contributes to that of the total angular momentum Λ and which is identical with the Stark effect quantum number m_l of the atoms. The electrons are called $\sigma, \pi, \delta \ldots$ electrons, if λ is $0, 1, 2 \ldots$ in analogy to the *s*, *p*, *d* electrons of the atoms. They form quantum groups or "orbitals" and the maximal number of electrons in a σ group is 2, that in the π group 4, because this includes the values $m_l = +1$ and -1. In a polyatomic molecule, however, the two directions parallel and antiparallel to the field are no longer degenerated, and the π group is split into two pairs. The molecule CH, for instance, with its 7 electrons, may be considered as a N atom, whose nucleus is divided into two parts, of which one possesses 6, the other one, 1 charge, and which are slightly separated from each other. The two 1*s* and the two 2*s* electrons of N can become σ electrons only, because, for $l = 0$, $m_l = \lambda$ can have no other value but 0. The *p*-electrons, however, can become σ or π electrons, because for $l = 1$, $m_l = \lambda$ may have the values 0 and ± 1. If we denote by superscripts the number of electrons in each group (if more than one is present), we obtain the following electronic configurations for the CH molecule :—

$$1s\sigma^2 \quad 2s\sigma^2 \quad 2p\sigma^2 \quad 2p\pi.$$

Of the three *p* electrons, the first two have populated the $p\sigma$ group, the third, not finding a place there according to Pauli's principle, has gone into the $p\pi$ group. The order in which the orbitals are written, is an energetical order. The more we proceed towards the right-hand side, the less energy is necessary, to ionise the molecule. This way of writing gives us also the contribution of each electron to Λ. At the same time each electron contributes $\frac{1}{2}$ to the spin quantum number S. For both quantum numbers, however, we have not to pay regard to the electrons on the closed orbitals, here the first three, because all the vectors are counterbalanced, and the character of the ground term of CH is determined only by the single π-electron. Two vectorial positions of L and S are possible and the term is a $^2\Pi$ term. In the molecule HF, three electrons more are present and fill the three empty places in the $2p\pi$ orbital. Its electronic configuration is, according to that of the Ne atom,

$$1s\sigma^2 \quad 2s\sigma^2 \quad 2p\sigma^2 \quad 2p\pi^4,$$

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* Presidential address, delivered in the Physical Society, Aligarh, March 26th, 1936.

[1] References of the theoretical investigations will be found more or less complete in the following papers: J. H. Van Vleck and A. Sherman: *Rev. Mod. Phys.*, 1935, **7**, 167; R. S. Mulliken, *J. Chem. Phys.*, 1935, **3**, 375; H. Lessheim and R. Samuel, *Proc. Ind. Ac. Sci.*, (Bangalore), 1935, **1**, 623. For experimental results *cf.* W. Jevons, Report on Band Spectra, London, 1932, and H. Sponer, *Molekuelspektren*, Berlin, 1936.

The number of papers which are connected with this subject, is very large and only a few having a direct bearing on the controversial points are quoted in detail.

This configuration is only made up of closed groups and the quantum numbers are $\Lambda = 0$ and $S = 0$, the resulting state is a $^1\Sigma$ term.

In this description, treating CH as N and HF as Ne, we have used the conception of the "united atom", *i.e.*, we have assumed, that the two nuclei are so close to each other, that they nearly coincide. It is assumed, that the field still resembles a central field as in an atom, so much so that the quantum numbers n and l of the atom retain their significance. This is true among the hydrides because they possess particularly small internuclear distances, the proton having no dimensions in the ordinary sense. We are thus able, to use these known quantum numbers to determine the unknown ones of the molecule. Generally, however, the field does not possess an approximately central character, but has only axial symmetrie. Then it is not possible, to imagine the distance between the two nuclei shortened more and more, till the molecule becomes a "united atom" because the quantum numbers of the latter one have lost their significance for the actual molecule. In this case we have to determine the values of λ from the quantum numbers of the separated atoms. In the symbols $1s\sigma$, etc. just as we have written the quantum numbers n and l of the "united atom", before the λ of the molecule, so we shall now write the corresponding n and l values of the separated atoms behind λ and get for the lowest orbitals, again in energetical order,

$\sigma(1s)\ \sigma(1s)\ \sigma(2s)\ \sigma(2s)\ \pi(2p)\ \sigma(2p)\ \pi(2p)\ \sigma(2p)$

The configuration of the ground state of the molecule NO, in which we have two $1s$ groups, two $2s$ groups and together seven p-electrons, is $\sigma^2(1s)\ \sigma^2(1s)\ \sigma^2(2s)\ \sigma^2(2s)\ \pi^4(2p)\ \sigma^2(2p)\ \pi(2p)$ and the term, exactly as that of CH, is a $^2\Pi$ term. The two groups $\sigma(1s)$, *i.e.*, the K shells of N and O, remain for all practical purposes localised in the neighbourhood of their own nuclei and form so called "atomic orbitals". The configuration proper of the molecule is formed by the following electrons of the L shell, which in this case are on "molecular orbitals". From this distinction the whole method has received its name.

Premoted and Non-Premoted Electrons.

From the above it will be seen that the energetical order of the electronic groups in the molecule is different for the two methods of interpolation, *viz.*, from the view-point of the "united atom" and from that of the separated system. For small internuclear distances we obtained the order $\sigma\sigma\sigma\pi\sigma\sigma\pi$.., for bigger ones $\sigma\sigma\sigma\sigma\pi\sigma$.... The reason for this is the operation of Pauli's principle. Two separated atoms like C and O possess each a completed K shell, *i.e.*, together four $1s$ electrons. But the corresponding united atom, in this case Si, can have only one $1s^2$ group. If we consider the CO molecule as an interpolation between the two extreme cases, and shorten the distance between the two atoms more and more, two of the four $1s$ electrons have to find during this process a place somewhere else in the electronic configuration of the two centre system. As a matter of fact, these two electrons will of course remain as σ electrons, but will form the group $2p\sigma$ in the united atom. In other words, if we have the two nuclei stripped of all electrons and fixed once at a small and once at a large internuclear distance and let in the electrons now being captured by them, we get different configurations. If the distance is large (the field of axial symmetry) the third electron becomes a $1s$ electron. If the distance is small (approximate central symmetry), the third electron will go into the group $2s$. Similar considerations apply to other groups, and this rearrangement of the groups can be seen, if we write the electronic configuration of a molecule with all quantum numbers, namely those of the "united atom" as well as those of the separated system. That of NO may serve as an example:

$$1s\sigma^2\,(1s)\ \ 2p\sigma^{*2}\,(1s)\ \ 2s\sigma^2\,(2s)\ \ 3p\sigma^{*2}\,(2s)\ \ 2p\pi^4\,(2p)\ \ 3s\sigma^2\,(2p)\ \ 3d\pi^*\,(2p).$$

Among the electronic groups there are three (marked by asterisks), which on increasing internuclear distance go into higher orbitals, from $1s$ to $2p$, from $2s$ to $3p$, from $2p$ to $3d$ respectively. Such electrons are called "premoted" the other ones non-premoted. The energetical relation between the orbitals at various values of r was first calculated for H_2^+ and later generalised for other molecules by Hund, and is shown in the diagram of Figure 1. This correlation table

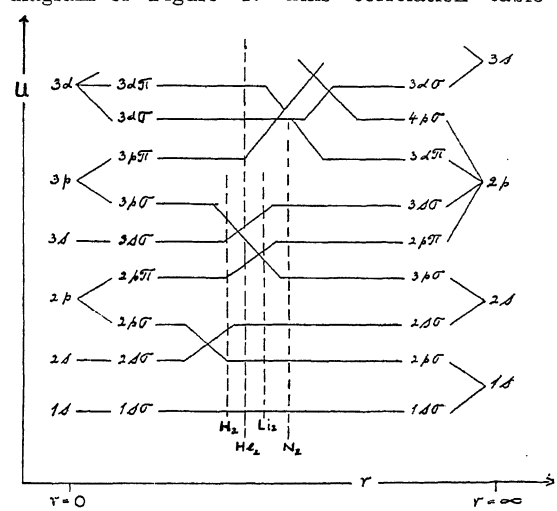

Fig. 1.

indicates the energetical order of the molecular orbitals for any internuclear distance from $r = 0$ to $r = \infty$. For a number of molecules the probable value of r is indicated and going along the dotted line, we can read off the series of electronic groups. At the same time the different heights of the groups above the abscissa indicates the energy. It can be seen that the energy to tear off the electrons generally decreases with increasing quantum numbers and, furthermore, that on decreasing internuclear distance the system of two atoms loses energy by the process of premotion and gains energy by the non-premoted groups. A premoted group is bound with less energy than the corresponding non-premoted one.

The Process of Dissociation.

From the character of the term we construct such electronic configurations, which yield the required S and Λ values. The energies of excitation and dissociation (calculated from the harmonic and anharmonic constants) indicate, from which

term of the atoms in question the level of the molecule arises and gives us the quantum numbers of the electrons in the separated atoms. In this way it is mostly possible to select the true electronic configuration from among the possible ones.

In the case of a diatomic molecule we know that its potential energy can be expressed as a function of the internuclear distance between its constituent atoms. We thus obtain, as Franck pointed out first, the potential energy curve, which runs parallel to the axis of the internuclear distance so long as the system represents two separated atoms. This curve will show a minimum if the two atoms enter into chemical combination to form a molecule, but it will have no minimum in the case of an elastic impact of the two atoms, which does not lead to chemical linkage. If one or both of these atoms are excited from the very beginning of molecular formation, then the horizontal part of the curve is higher by an amount which is given by the excitation energy of the atom or atoms concerned. If now the atoms combine to form a molecule, we obtain the curve of potential energy of an excited electronic level which again may or may not exhibit a minimum. In this way we may obtain a number of potential energy curves for a molecule which represent the various electronic levels of the molecule in different electronic configurations. The potential energy curves which do not show a minimum also come under this category.

Let us consider the lowest of such potential curves. Its trough represents the various vibrational energy levels that belong to the molecule and here the equilibrium position or roughly the minimum of the curve indicates the internuclear distance in that state of the molecule, where it is in its lowest vibrational level. The difference in the energy between this position and the position of the separated atoms gives the dissociation energy D'' of the molecule. If the molecule absorbs light of a certain energy ν_0 its electronic configuration is changed and we obtain an excited term. Its energy of dissociation D' correlates it with the level of the separated atoms of which now, at least in many cases. one is excited. The difference $\nu_0 + D' - D''$ equals the energy of excitation of this atom. Thus in H_2 (Fig. 2) the ground-level $^1\Sigma$ has the electronic configuration $1s\sigma^2$ and the dissociation energy 4.47 volts. By removing one electron into an excited group, the term $1s\sigma\ 2p\sigma\ ^1\Sigma$ obtains, ν_0 being 11.13 volts, $D' = 3.47$ volts. The difference $\nu_0 + D' - D'' = 10.15$ volts gives the energy difference of the separated system and agrees very well with the energy of the first line of the Lyman series at 1215·7 A.U. Hence the ground-level is formed by two normal H atoms both in the term $1\,^2S$, the excited level of the molecule by one normal and one excited atom in the term $2\,^2S$. In both states of the molecule the electrons counterbalance their spin, the two molecular states being singlet terms. If two normal H atoms approach each other the electrons having parallel spin, a $^3\Sigma$ level results, which is a repulsive term, the $U : r$ curve not possessing any minimum. This term is the final level of the continuous emission spectrum of hydrogen.

To take another example, the above configuration of the ground state of NO contains four $2s$ and seven $2p$ electrons and therefore arises

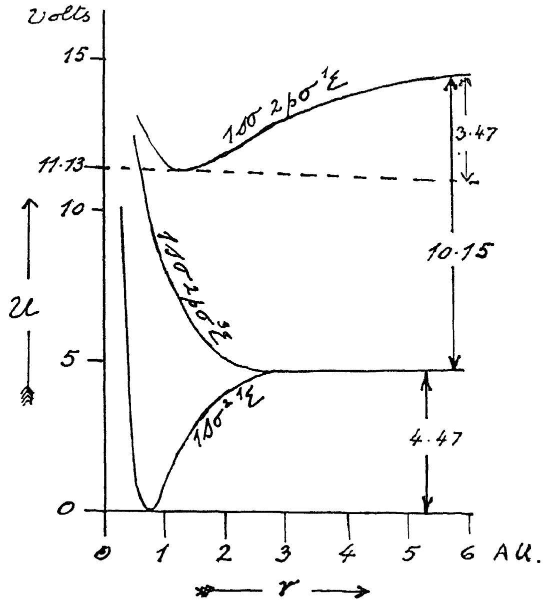

Fig. 2.

from the combinations N $(2s^2\ 2p^3)$ + O $(2s^2\ 2p^4)$, which are those of the unexcited atoms. But

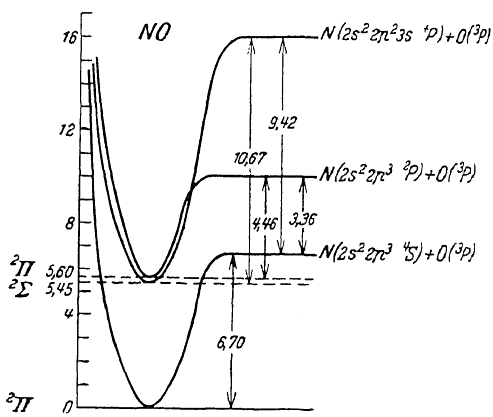

Fig. 3.

besides the ground terms ^4S and ^3P respectively also other terms, *i.e.*, ^2D and ^2P of N and ^1D and ^1S of O, have the same electronic configuration. However, NO fortunately possesses the excited electronic level $^2\Pi$ and, according to the dissociation energy of this term, it arises from the combination of two atoms, one of which is excited by 3·4 volts. This agrees with the energy of excitation of the excited $(2s^2\ 2p^3\ ^2P)$ term of N and proves, that the ground-level of the molecule is formed by two unexcited atoms. A third term of NO, $^2\Sigma$, is interesting, because its energy of dissociation is bigger than that of the ground-level. It is correlated to O $(2s^2\ 2p^4\ ^3P)$ + N $(2s^2\ 2p^2\ 3s\ ^4P)$. The electronic configuration of the molecule in this state is therefore (if we abbreviate the atomic orbitals of the K shells by K_1 and K_2) :—

$$K_1\ K_2\ 2s\sigma^2\ (2s)\quad 3p\sigma^2\ (2s)\quad 2p\pi^4\ (2p)\quad 3s\sigma^2\ (2p) - 3s\sigma\ (3s).$$

We find that the partial removal of the odd $3d\pi$ $(2p)$ electron increases the energy of dissociation, or in other words, if the electron, which later on remains unpaired in the molecule, is already removed to the M shell in the N atom, a molecule with an increased bond energy is formed. This interpretation, confirmed by the bands of PO, AsO and SbO, appears to be important for a theory of valency.[2]

In similar ways we learn that the s^2 group of the earth alkali metals acts repulsively. The ground state of the molecules of the BeO and BeF type does not arise from the combination of unexcited metal atoms in the term $s^2\,{}^1S$ with O and F, Cl, etc., but from that of excited metal atoms in the term $sp\,{}^3P$, the helium-like s^2 group having been previously fissured. This result is of interest, because it shows, that also a non-premoted group may act repulsively. For some time, because the extrapolation of the dissociation energy is never entirely accurate, this result was doubted, but to-day it is proved in two ways. Some of the molecular terms have to be correlated to terms of atoms, in which two electrons are excited simultaneously (the so-called anomalous terms) and this shows, that already one electron was excited in the dissociation products of the ground-level. A clear decision is furthermore given by the spectrum of CdF. Here the energies of excitation of the metal are increased, Cd belonging to the sub-group of the Periodic Table and therefore the only possible correlation proves beyond doubt that the metals of the second group are chemically inert, so long as the s^2 group of electrons remains undisturbed.[3]

Development of the Orbital Method to a Theory of Valency by the Introduction of New Postulates.

Proceeding from the description of the electronic configuration and term system of the molecule, to questions of valency, we shall again take up the view-point of the method of molecular orbitals. Here, however, the answers furnished by the theory are not so clear as for the problems dealt with above. Whereas these latter concerned the completed molecule, *i.e.*, the system of two atoms at small internuclear distances, for which the method of molecular orbitals is singularly adapted, questions of valency invariably involve the process of dissociation (or its converse, the process of formation) of the molecule, *i.e.*, are dealing with the same system at large internuclear distances, which is already somewhat outside the scope of the orbital method.

If two atoms undergo chemical combination, the ground state of the molecule possesses a potential curve with a minimum at a particular internuclear distance. Only by means of introduction of energy it is then possible either to increase or to decrease the distance of the two atoms and the minimum of the $U:r$ curve is therefore the necessary condition of molecular formation. Any theory of valency on the basis of band spectroscopy has therefore at first to show, which of the curves of the possible electronic configurations possess a minimum and which not, or, in other words, which of them is an attractive curve and which a repulsive one. The next step will then be, to find out, what distinguishes the wavefunctions of the attractive terms from those which belong to the repulsive ones.

The method of molecular orbitals as such does not furnish any answer to both these questions at the present state. It is not qualified to distinguish between the attractive and repulsive curves nor to give the amount of energy of dissociation. The reasons, as we shall see, are inherent to this method; they are connected with its general inability to describe the system at larger internuclear distances and due to the same principle which brings about its advantages, *i.e.*, that the interaction of the electrons does not play any part in it. It is therefore necessary to introduce new conceptions into the method of molecular orbitals, but from the very beginning it should be emphasized, that such a procedure means the *introduction of new postulates*, and it is not on the method of molecular orbitals but on these postulates, that the theory of valency is based.

The first postulate, introduced particularly by Herzberg and Mulliken, is, to identify premoted and non-premoted electrons with anti-bonding and bonding electrons respectively. A premoted electron of a molecule is bound with less energy than the corresponding non-premoted one. It is assumed, that a premoted or non-premoted electron tends to make the $U:r$ curve repulsive or attractive respectively. The $U:r$ curve of the particular molecule is conceived to be made up from the single terms of the single electrons, the correlation table indicates the loss or gain of energy per single electron and as a matter of principle it is assumed, that the grand total of these energy changes of the single electrons describes that of the molecule as a whole. In reality, however, the correlation table shows only that a premoted orbital is higher than the corresponding non-premoted one, but it is unable to indicate, whether both together are higher or lower than the correlated ones in the atom. This correlates a particular orbital, say $1s$, to a particular orbital in the molecule, say $1\sigma\,(1s)$ but we do not know, if the left-hand side of the table, which refers to the molecule, lies as a whole higher or lower than the right-hand side of the separated atoms. To avoid this difficulty, Mulliken fixes the energy relation of the lower ends of the two sides once for all by referring to H_2^+. Here the potential curve of the single electron can be accurately determined, because only one electron is present. The curve of the non-premoted $1s\sigma\,(1s)$ electron is that of the ground-level of this molecule ion and it is concluded, that it is attractive, *because* the orbital is a non-premoted one. In the neutral molecule H_2 a second electron is present, which finds its place in the same orbital. In He_2, however, the third and fourth electrons populate the next orbital, on account of Pauli's principle, and this, *i.e.*, $2p\sigma\,(1s)$ is a premoted group. Thus the effect of the two first bonding electrons is counterbalanced by that of the two last anti-bonding electrons and therefore chemical combination of two He atoms is not possible.

Here the wavemechanical interaction, which is

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[2] (*a*) H. Lessheim and R. Samuel, *Z. Phys.*, 1933, **184**, 637; 1934, **88**, 276; (*b*) *Phil. Mag.*, 1936, **21**, 41. (*c*) P. C. Mahanti, *Ind. Jour. Phys.*, 1935, **9**, 517.

[3] (*a*) G. Herzberg, *Z. Phys.*, 1929, **57**, 601; H. Lessheim and R. Samuel, *loc. cit.* (*b*) R. K. Asundi, R. Samuel and Mohd. Zaki-Uddin, *Proc. Phys. Soc.* (London), 1935, **47**, 235.

due to the equality of the electrons and is the decisive bonding effect in Heitler and London's calculation, is neglected, because the whole argumentation is solely based on the conditions of H_2^+, where only one electron is present and therefore no interaction with a second electron is possible. *If* linkage generally is due to this interaction, the non-existence of a stable He_2 molecule (formed by unexcited atoms†), will then indicate, that the orbital $1s\sigma$ (1*s*) lies still below $2p\sigma$ (1*s*) but that both the orbitals, the non-premoted one as well as the premoted one, together are higher than in the separated system, *i.e.*, they are anti-bonding, because in the He atom they form closed shells $1s^2$, and the energetical relation of the right and left-hand side of the correlation table in H_2^+ does not permit generalisation. This is corroborated by certain difficulties, which the theory encounters in the case of the molecule LiH, which possesses the same number of electrons as He_2, but exists with an energy of dissociation of 2.5 e.v. It can be shown that there is no other explanation of this rather high energy value possible, but to accept Lennard-Jones' manner of counting by neglecting the closed shells and to consider the valence electron of Li as well as that of H as a 1*s* electron. In this case both of them are bonding electrons but then already one of them should be sufficient for the formation of a stable molecule and the molecules HeH or LiH^+ should exist too. Experimental evidence and wavemechanical calculation show, however, that they do not exist. Furthermore, experimental evidence shows, that H_2^+ is indeed the only example of a molecule with a single valence electron, that not only HeH and LiH^+ but also molecules of the type Li_2^+ or BeH^{2+} do not exist, whereas the corresponding molecules with *two* valence electrons are all well known spectroscopically, *i.e.*, molecules of the type LiH, Li_2, BeH and BeH^+.

In this theory the bonding effect is due not to the interaction of the electrons but to the degeneracy of the nuclear fields. In H_2^+ the fields of the two nuclei are indeed completely identical and Hund has shown, that a single electron possesses bonding power also, when the nuclear fields, short of being identical, are only approximately degenerated. Such a theory of valency considers this effect based on the degeneracy of the fields as the predominating bonding effect, the formation of electron pairs in the molecule being then only incidental. Since this bonding effect is produced by the single electron, the interaction of electrons need not be considered except as a superimposed secondary effect. This conception can be made use of as a wavemechanical interpretation of those chemical theories of valency, which have been developed particularly by Langmuir, Lowry, Sidgwick a.o.,[4] and in which certain types of chemical bonds are brought about by the electrons of one atom only (the "donor") without interaction with electrons of the second atom, and from the original literature it can be seen, that the interpretation of the method of molecular orbitals as a single-electron bond theory of valency has indeed been sponsored by the requirements of the theory of this school of chemical thought.

We have seen that the basic postulate of this interpretation, *i.e.*, the identification of premoted and non-premoted electrons with anti-bonding and bonding electrons has been introduced into the orbital method by fixing the energy relation of the right and left-hand side of the correlation table according to the ground state of H_2^+. In a similar way the postulate of the second possible interpretation of the same method goes back to the neutral molecule H_2. Here the emphasis is laid just on the second bonding effect, produced by the equality of the electrons. Since the electrons are always identical, this degeneracy remains always present and does not require the additional assumption of approximate degeneracy of so vastly different fields as, *e.g.*, C^{2+} and O^{4+} in CO or Be^{2+} and F^{5+} in BeF. So that wave-mechanical interaction is brought about and chemical linkage produced by the formation of *electron pairs* in the molecule. Accordingly it is assumed that an attractive U : *r* curve arises, when electrons of different atoms join in the same molecular orbital, as in the ground state of H_2. The premotion of the electrons plays the rôle of a superposed secondary effect only. Unpremoted orbitals contribute more, premoted orbitals less to the energy of formation, but if a premoted orbital is populated by a pair of electrons, one of either atom, the effect of the interaction may vastly prevail over that of premotion and the total contribution may still be positive. Thus the $^1\Sigma$ term of H_2, which arises when the electrons of the two unexcited atoms enter the premoted orbital $2p\sigma$ (1*s*) is not only stable, but this configuration satisfies also the criterion of linkage of the Slater-Pauling theory, the wave-functions of the two electrons overlapping. Such a theory leads to the interpretation of the method of molecular orbitals as a pair bond theory of valency and approaches therefore the other wavemechanical methods of Heitler, London, Slater and Pauling. If we compare it with chemical theories of linkage, it may be considered as a wavemechanical interpretation of the pre-wavemechanical pair bond theory of Lewis and its development by Grimm and Sommerfeld.[5]

To our mind recent developments of band spectroscopy have decided more and more against the identification of bonding with non-premoted and anti-bonding with premoted electrons. We mentioned above the spectra of molecules like BeO and BeF, which clearly show that the unexcited metal atoms in the term $s^2\,{}^1S$ do not undergo chemical combination. But Be ($s^2\,{}^1S$) + O ($s^2p^4\,{}^3P$) or + F ($s^2\,p^5\,{}^2P$) should form a stable molecule if the above assumption were correct. The premoted and non-premoted σ groups cancel out and there remain four or five *p*-electrons respectively, all on non-premoted orbitals. As a matter of fact, unexcited Be + unexcited O should form a molecule BeO possessing a triplet term, but experimentally we get a singlet term as the ground level of these molecules. The further assumption, that it originates from Be (^1S) + O (^1D) fails, because the correlation of the molecular term to those of the separated atoms, described above, clearly indicates that

† Indeed a molecule He_2, formed by excited atoms, exists.

[4] *Cf.* N. V. Sidgwick, *The Electronic Theory of Valency*, Oxford, 1927, and contributions to the *Annual Reports of the Chem. Soc. London.*

[5] *Cf.* H. G. Grimm, *Handb. d. Physik*, 1933, XXIV.

the ground-level of BeO involves an excited Be atom and this is corroborated by the spectrum of BeF. This correlation has been used already for about a dozen of molecules of these two types and cannot be taken to be fortuitous. Here clearly exist two electronic configurations, which both should produce stable terms of the molecule according to the single electron bond interpretation of the method of molecular orbitals, but instable terms according to the pair bond theory of valency—and the experiment shows definitely, that these stable terms do not exist. The conclusion, that not the premoted but the odd electron weakens the chemical bond is again at once confirmed by the spectra of all the molecules of NO type, *i.e.*, NO, PO, AsO and SbO.

Furthermore, new spectra are again entirely consonant with this view. Molecules like AlO and GaO behave similar to BeO and MgO. In its unexcited configuration s^2p the metal atom forms only a single link with oxygen and the double bond comes into existence only after the original s^2 group of the metal atom has been broken up. Those excited terms, which possess a higher energy of dissociation than the ground-level on account of the double bond, therefore dissociate into oxygen and an excited metal atom in the configuration sp^2. Again SiF and SnCl behave like BeF, MgF, or NO; they are odd numbered and increase their energy of dissociation by the partial removal of the odd electron, which does not take part in the linkage[6].

If we do not take into consideration hydrides, which approach the "united atom", but ordinary diatomic molecules, then we must say, that the interpretation of band spectra during the last few years has changed the whole basis for the interpretation of the method of moleculer orbitals as a theory of valency. There is ample experimental proof for the conclusion, that not non-premoted electrons, but electrons, which join in the same orbital with other ones of the second atom confer stability to a molecule and that not premoted electrons disturb the linkage but the unpaired ones. These new results, obtained from new correlations and new spectra are so uniform and follow so closely the predictions of the pair bond theory, that there seems to be little or no doubt for the experimentalist. How far they may serve as the basis of the theory of valency will be seen from a more general survey.

[6] For molecules of the type GaO and SiF, *cf.*, forthcoming papers of R. K. Asundi and R. Samuel, *Proc. Ind. Ac. Sci.* (Bangalore), in press.

(To be Continued.)

Recent Advances in Sanitary Science.

THE following is the extract of an address delivered by Dr. Gilbert J. Fowler, before the Joint Session of the Association of Economic Biologists, Coimbatore, the Indian Academy of Sciences, the Indian Chemical Society (Madras Branch), the Institute of Chemistry of Great Britain and Ireland (Indian Branch), the Society of Biological Chemists, India, and the South Indian Science Association, Bangalore, held at Bangalore on 10th April 1936.

Dr. Fowler dealt with the recent researches on water purification, with particular reference to Madras, the study of sewage-sick soils and the sewage problems of Madras and Ahmedabad. Finally he spoke of recent researches and discussions on the manufacture of compost from waste materials.

Introducing the subject he thanked the President (Dewan Bahadur N. N. Iyengar) for his kind reference to the work which had been done in connection with the provision of compost for the villagers. It was a great encouragement to him that his objective towards which he had devoted a good many years of work seemed now within sight of fulfilment. He referred to a recent address by Sir George Schuster to the Royal Society of Arts in London, where Sir George had quoted Lord Bacon to the effect that money was like muck, it was no good unless it was spread. The scientific utilisation of waste materials for the use of agriculture was a true spreading of wealth. We heard that nowadays in England the distribution by Government of free milk to necessitous school children was an accomplished fact. Such a policy would have been hardly conceivable not so many years ago, yet now it was realised that the safeguarding of the health and well-being of the future generation was the best possible investment a country could make. There was in England at the present time a movement with the object of converting the sewage works of the country into Fertiliser Factories. The economics of this question had awakened vigorous discussion. One school, supported mainly by engineers, was in favour, *e.g.*, of discharging all the sewage of London through a long tunnel into the sea. Another school, representing Biochemistry and Agriculture, was averse even to the water carriage system on account of its waste of fertilising material. In view of the large expenditure of capital on works of sanitation it was of the highest importance that the scientific foundations of the subject should be thoroughly investigated. In his (Dr. Fowler's) opinion, the true solution of the problem would only be found in a close adherence to Nature's cycle. Recent research by McCarrison, Howard and others had shown the immense importance of certain factors which must be present in the food of plants and consequently of animals if the processes of life were to function satisfactorily. It was the little extra something, be it vitamin or hormone, protein cleavage product or whatever it might be named which was characteristic of living process, which determined the health and well-being of the plant and the animal which fed thereon.

Having these considerations in mind, it was interesting to note that the largest modern sewage works, *viz.*, at Mogden (West Middlesex, England) involved a capital cost of approximately £1,700,000 which was almost the same as the capital value of the Kolar Gold Fields. The question arose, which was the more valuable, Nitrogen or Gold?

Recent Researches in the Theory of Meromorphic Functions with Special Reference to the Picard-Borel Theorem.*

Part II.

(Concluded.)

SUPPOSE $f_1(z)$ and $f_2(z)$ be two rational functions which are such that the places at which they take two given values (for simplicity take these to be 0 and ∞) are identical. (The same order of multiplicity.) Then it is easy to see that they are identical except for a constant. What is the corresponding theorem in the case of two meromorphic functions? The most important theorems in this connection are due to Nevanlinna. His first theorem shows that if for five different a_ν's the equations (1) $f_1(z) = a_\nu$ (2) $f_2(z) = a_\nu$, have identical solutions in z, then the functions are identical. (The functions are meromorphic.) This is proved as follows. Let us introduce the following functions:

$$m_r(f_1, f_2) = \frac{1}{2\pi}\int_0^{2\pi} \log [f_1, f_2]^{-1}\, d\theta.$$

$n(r, f_1 - f_2)$ = the number of zeros of $f_1 = f_2$ in $|z| \leqslant r$. $N(r, f_1 - f_2)$ being defined as before. By the method of proof of the first fundamental theorem it is obvious that

$T(r, f_1) + T(r, f_2) = m_r(f_1, f_2) + N(r, f_1 - f_2)$
$> N(r, f_1 - f_2)$. Let the order of $T(r, f_1)$ be greater than that of $T(r, f_2)$ for definiteness. Then $2T(r, f_1) > N(r, f_1 - f_2)$. Let us denote the functions corresponding to $f_1(z)$ by N, m, etc. Then a little consideration will show that $N(r, f_1 - f_2) > \Sigma N(r, a_\nu) - \bar{N}(r)$. $\therefore 2T(r, f_1) > \Sigma N(r, a_\nu) - \bar{N}(r)$. But from II, taking $q = 5$, $3T(r, f_1) \leqslant \Sigma N(r, a_\nu) - \bar{N}(r) + 0[\log r\, T(r)]$. Combining the two we obtain $\underline{\text{Lim}}\, \frac{\log T(r, f_1)}{\log r} < \infty$. $\therefore$ both f_1 and f_2 are rational functions and in that case they are obviously identical. [It is to be noted that we have not at all assumed that f_1 and f_2 take the values a_ν with the same orders of multiplicity. We have merely assumed that they take it at the same places.]

Next we take up the question of the identity of two functions if the distribution for four a_ν's are the same. The results obtained in this case are in a sense incomplete. Nevanlinna has proved that in case the functions take the four values at the same places with the same orders of multiplicity then the functions are identical except in a special case wherein the a_ν's are harmonic and two of them are lacunary values for both the functions; in that case, the two functions are connected by a homographic relation. But no corresponding result in case the restriction about the same order of multiplicity is removed is known. In order to prove these results we have to prove first of all some theorems in connection with meromorphic functions connected by a linear relation and having two lacunary values. This itself is an important chapter in the theory which was started by Borel and developed by Bloch and Nevanlinna; its application to the problems of unicity is due to Polya.

Before proceeding to the proofs of these results we mention a few results which are obvious from the definitions themselves.

(1) $T(r, f) = T\left(r, \frac{1}{f}\right) = T\left(r, \frac{af + b}{cf + d}\right) + 0(1)$.

(2) $T(r, f_1 + f_2) \leqslant 2T(r, f_2) + T(r, f_2) + 0(1)$.

(3) $T(r, f_1 f_2) \leqslant T(r, f_1) + T(r, f_2)$.

Now Picard's theorem can be stated in another form. Suppose an integral function does not take the values 0 and 1; *i.e.*, if $f = e^{g_1}$, $1 - f = e^{g_2}$ where g_1 and g_2 are integral functions, then $e^{g_1} + e^{g_2} = 1$. Picard's theorem asserts that such an equation cannot hold unless when g_1 and g_2 are suitable constants. Borel generalised this result in the following way. Suppose we have a relation of the form $\sum_1^n c_\nu \phi_\nu = 0$ where ϕ_ν's are integral functions which do not take the value zero say. Then, if they are linearly independent, their mutual ratios should be constant. [If they are not linearly independent it should be possible to break up the equation into a number of equations in each of which the functions that occur are linearly independent. The result will be true for each of the new equations.] In order to prove these results we have to deduce the second fundamental theorem in a form deduced by Nevanlinna originally by means of which he deduced II. The theorem is the following:

II'. $m\left(r, \frac{f'}{f}, \infty\right) = 0[\log r\, T(r)]$ [except for the exceptional intervals. To be always understood].

We give here a new proof by adopting the method of Ahlfors.

Now

$$\lambda(r) = \int_0^{2\pi} \frac{|f'|^2 \rho(f)}{[1 + |f|^2]^2}\, d\theta. \text{ Take}$$

$$\log \rho(f) = 2 \log [f, 0]^{-1}. [f, \infty]^{-1} - \beta \log [\log [f, 0]^{-1}. (f, \infty)^{-1}] + C$$

where C is such that the total density is unity, $\beta > 1$, so that the integral is convergent. Substituting the values for $[f, 0]$, etc., and simplifying we have

$$(1)\quad \lambda(r) = K\int_0^{2\pi} \left|\frac{f'}{f}\right|^2 \left[\log \frac{1 + |f|^2}{|f|}\right]^{-\beta} d\theta$$

and

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* Abstract of lectures delivered by K. Venkatachaliengar to the Central College Mathematical Society, Bangalore.

$$(2)\quad \frac{1}{2\pi}\int_0^{2\pi}\left[\log\frac{1+|f|^2}{|f|}\right]^{-\beta} d\theta$$

$$=\frac{1}{2\pi}\int_0^{2\pi}\left[\log\left(|f|+\frac{1}{|f|}\right)\right]^{-\beta} d\theta$$

$$\geqslant (\log 2)^{-\beta}. \quad \text{[K is a constant.]}$$

Utilising this we obtain

$$\frac{\lambda(r)+K(\log 2)^{-\beta}}{2K\pi} \geqslant \frac{1}{2\pi}\int_0^{2\pi}\left[1+\left|\frac{f'}{f}\right|^2\right] \times \left(\log\frac{1+|f|^2}{|f|}\right)^{-\beta} d\theta.$$

Taking logarithms and utilising the fact that the logarithm of the mean is $\geqslant$ the mean of the logarithms we obtain

$$\log\lambda(r)+0(1) \geqslant m\left(r, \frac{f'}{f}, \infty\right) - \frac{\beta}{2\pi}\int_0^{2\pi}\log \cdots\cdots$$

$$[\log (f, 0)^{-1} (f, \infty)^{-1}]\, d\theta.$$

$$\text{As } \beta > 1 > 0, \geqslant m\left(r, \frac{f'}{f}, \infty\right) - \beta \log \cdots\cdot \frac{1}{2\pi}\int_0^{2\pi} \log [f, 0]^{-1} [f, \infty]^{-1}\, d\theta.$$

$$\therefore m\left(r, \frac{f'}{f}, \infty\right) \leqslant \log\lambda(r) + 0(1) + \beta \log [m (r, 0) + m (r, \infty)].$$

As $\log \lambda(r) = 0 [\log r\ T(r)]$ except in the exceptional intervals we have II″. $[m(r, 0) + m(r, \infty) < 2\,T(r)]$. [For the deduction of II from II″ see Nevanlinna's excellent tract.]

We state and derive Borel's theorem in a slightly different way which is seen to be the same after a little reflection. Suppose $\phi_1, \phi_2, \cdots \phi_n$ be any n integral functions which are linearly independent ($\therefore$ their Wronskian is $\not\equiv 0$) and which are connected by the linear relation $\Sigma\phi_\nu = 1$. Then, if they have a common lacunary value they are all constants. This is proved as follows. For simplicity let us assume that $n = 3$ and the common lacunary value is 0. We have

$$-(1-\phi_1)+\phi_2+\phi_3 = 0.\quad \phi_1'+\phi_2'+\phi_3' = 0,$$

and $\phi_1''+\phi_2''+\phi_3'' = 0$.

$$\therefore \frac{1}{\phi_1} = \begin{vmatrix} 1 & 1 & 1 \\ \frac{\phi_1'}{\phi_1} & \frac{\phi_2'}{\phi_1'} & \cdots \\ \frac{\phi_1''}{\phi_1} & \cdots & \frac{\phi_3''}{\phi_3} \end{vmatrix} \times \begin{vmatrix} \frac{\phi_2'}{\phi_2} & \frac{\phi_3'}{\phi_3} \\ \cdots & \frac{\phi_3''}{\phi_3} \end{vmatrix}^{-1} = \frac{D}{\Delta}, \text{say}$$

$\therefore \phi_1 = \dfrac{\Delta}{D}$ [let us use the symbol $T_n(r)$ for $T(r, \phi_n)$].

Let $T(r)$ be of the greatest order among all the characteristic functions that occur. Using the results on the characteristic functions of products and sums of functions, and writing

$$\frac{\phi_2''}{\phi_2} = \frac{\phi_2''}{\phi_2'}\cdot\frac{\phi_2'}{\phi_2}, \text{ etc.} \quad \text{we obtain by II}''$$

$T_1(r) \leqslant N(r, \phi_1, \infty) + N(r, D, \infty) - N(r, D, 0) + 0 [\log r.\ T(r)]$.

Now $D = W\phi_1\phi_2\phi_3$, where W is the Wronskian of the ϕ's. Writing the $N(r, D)$'s in terms of $N(r, \phi)$'s and $N(r, W)$ we obtain $T_1(r) = 0 [\log r.T(r)]$, utilising the hypothesis that the ϕ's do not take the values 0 or ∞. From this it is clear that the ϕ's are polynomials which contradicts the hypothesls that the ϕ's are not zero. Hence, the ϕ's are constants. [A slight generalisation is possible, *i.e.*, we can assume that ϕ's take 0 and ∞, also. They should only assume them relatively rarely. [$N(r, 0)$ and $N(r, \infty) = 0 [\log r.\ T(r)$.]

Now we apply this result to the theorem on unicity mentioned earlier. f_1 and f_2 are two meromorphic functions which take four given values a_1, a_2, a_3 and a_4 at the same places with the same order of multiplicity. Then, we prove either (1) They are identical or (2) two of these are lacunary values for both f_1 and f_2, the cross-ratio $(a_1\ a_2\ a_3\ a_4) = -1$, and f_1 and f_2 are connected by a homographic relation. Let us assume a_4 to be ∞.

$$\left[\text{If it is not so, consider } \frac{1}{f_1 - a_4} \text{ and } \frac{1}{f_2 - a_4}\right].$$

Then

$$\phi_r = \frac{f_1 - a_r}{f_2 - a_r},\ r = 1, 2, 3$$

are integral functions with the common lacunary value 0. Eliminating f_1 and f_2 we obtain

$$\Sigma(a_2 - a_3)\phi_1 + \Sigma(a_2 - a_3)\phi_2\phi_3 = 0.$$

Applying Borel's theorem to the six functions $\phi_1 \ldots, \phi_2\phi_3 \ldots$ all of which exclude the value 0 and dividing them into groups in all possible ways, we obtain one of the following types of alternatives

$$(1)\ \frac{f_1 - a_1}{f_2 - a_1} = K\,(\text{const.})\quad (2)\ \frac{f_1 - a_1}{f_2 - a_1} = K.\ \frac{f_1 - a_2}{f_2 - a_1}$$

$$\text{or}\quad (3)\ \frac{f_1 - a_1}{f_2 - a_1} = K.\ \frac{f_2 - a_2}{f_1 - a_2}.$$

If (1) is true then in case the functions are not identical both a_2 and a_3 are lacunary values and as there cannot be more than two lacunary values $a_2 - a_1 = k\ (a_3 - a_1)$ and $a_3 - a_1 = k(a_2 - a_1)$ $\therefore$ $k = 1$ or the functions are identical. We can write (2) or (3) as $f_2 = S(f_1)$ where S is the homographic transformation; say, $f_2 = \dfrac{af_1 + b}{cf_1 + d}$.

Then either ∞ is a lacunary value or else $c = 0$. The latter case is disposed off as (1). $\therefore$ ∞ is a lacunary value. $\therefore$ $S(\infty)$ should also be a lacunary value for both. $S(\infty)$ should be one of the three a's or else there would be five values which has already been disposed off. And for the other two a's, $S(a) = a$ obviously. Hence, two of the values are fixed points of the homography and ∞ and the other a are corresponding points. Hence our theorem is completely proved. Nevanlinna has proved that if three functions take three values at the same places with the

same orders of multiplicity then at least two of them should be identical. From our analysis it is also clear that there do exist functions having four identical distributions.

FUNCTIONS MEROMORPHIC IN THE UNIT CIRCLE.

Our preceding analysis confines itself to the distribution of values of a meromorphic function in the neighbourhood of an isolated singularity. A generalisation of that would be the problem of distribution of values of a meromorphic function in the neighbourhood of a line singularity; or in a slightly more general way we consider the problem of distribution of a function given to be meromorphic in a given region (not necessarily simply connected; and the function need not be one valued but should be capable of being continued indefinitely with the exception of only poles as singularities). In such a case we have to uniformitise it; *i.e.*, we shall assume that we have transformed the region to the area of the unit-circle. Then our problem is divided into two. One is the nature of the polymorphic function which transforms the region and the other is that of the distribution of the values of a meromorphic function in the unit-circle. The former does not belong to the subject of the lecture. Therefore we take the latter problem and see how it differs from the earlier case.

The first fundamental theorem is easily seen to be true in this case also; but the fact that $T(r) \to \infty$ as $r \to \infty$ is not obviously true. For all functions which are analytic and bounded in the unit-circle $T(r)$ is certainly bounded. Nevanlinna has proved that if $T(r)$ is bounded then the function is the quotient of two bounded functions. [It is of course not necessarily bounded.] The following is a slightly simplified version of Nevanlinna's proof. $\therefore T(r)$ is bounded $N(r, 0)$ and $N(r, \infty)$ are both bounded. Evaluating the integral $N(r, 0) = \int_0^r \frac{n(r,0)}{r}\, dr$, and $N(r, \infty)$ we easily deduce the following; *i.e.*, if $r_1, r_2, r_3, \ldots\ldots$ be the absolute values of the roots of $f(z) = 0$, in the Unit-circle (multiplicity being taken into account). We obtain $N(1, 0) = \frac{1}{r_1\ r_2\ r_3 \cdots}$, $\therefore$ if $N(r, 0)$ is bounded $\Sigma(1 - r_n)$ is convergent. Let $a_1, a_2, \ldots, a_n, \ldots$ be the sequence of zeros of $f(z)$. $|a_n| = r_n$. Then, we show that the product $f_1(z) = \prod_1^\infty \frac{z - a}{1 - z\bar{a}_n}$ converges uniformly in $|z| \leqslant r < 1$. This is easily proved by finding the maximum and minimum values of $\left|\frac{z-a}{1-z\bar{a}}\right|$ in $1 < |a| < r \leqslant z$. We have

$$\frac{|a| + r}{1 + r|a|} > \left|\frac{z - a}{1 - \bar{a} z}\right| > \frac{|a| - r}{1 - r|a|}.$$

From this, it is easy to show that

$$\Sigma\left[1 - \left|\frac{z - a\nu}{1 - z\bar{a}\nu}\right|\right]$$

converges uniformly in the region considered. From this we deduce that the same is true of the product and $f_1(z)$ is a function which is bounded and analytic in the unit-circle. We similarly form $f_2(z)$ with the poles instead of the zeros of $f(z)$ in the unit-circle. Then it is easily seen $f(z) = e^{\psi(z)} \cdot f_1/f_2$, where $\psi(z)$ is analytic in $|z| \leqslant 1$. Now consider the circle $|z| = r$. Let A_r be the set of points on it for which $R(\psi)$ is non-negative and B_r its complement. Then we determine two functions which are analytic in $|z| < r$, say $\psi_1^{(r)}(z)$ and $\psi_2^{(r)}(z)$ which are such that $R\psi_1^{(r)} = R(\psi)$ on A_r and o on B_r and $R\psi_2^{(r)} = R(\psi)$ on B_r and o on A_r. Then in $|z| < r$. $\psi = \psi_1^{(r)} - \psi_2^{(r)}$. [We assume that a suitable imaginary constant is added.] For a sequence $r_n \to 1$ we determine ψ_1 and ψ_2 similarly. Then as $e^{-\psi_1^{(r)}}$ and $e^{-\psi_2^{(r)}}$ are bounded functions by Vitalis theorem [see *e.g.*, Bieberbach—*Lehrbuch der Funktionen Theorie*, Bd. I] there is a subsequence of (r_n) for which both $\psi_1^{(r)}$ and $\psi_2^{(r)}$ converge in $|z| < 1$ to two functions whose real parts are positive. Let these functions be ψ_1 and ψ_2 respectively. Then we can write $f(z)$ in the form $f(z) = \frac{f_1\ e^{-\psi_2}}{f_2\ e^{-\psi_3}}$. Both the numerator and the denominator are bounded.

We easily see that all other properties which are derived earlier to II are true for this case also; but the theorems on defective values, etc., are not true without some other restriction. We have examples for which $T(r) = 0 \cdots\cdots \cdots\cdot \left[\log \frac{1}{1-r}\right]$ which do exclude any number of values. A Fuchsian function with parabolic substitutions only, *viz.*, the function which transforms a circular polygon whose sides are arcs orthogonal to the unit-circle and which touch each other (on the unit-circle obviously) to the half-plane has the requisite property. [We omit the proof. See Nevanlinna, *loc. cit.*] The next point which needs amendment is the second fundamental theorem. The definition of the exceptional intervals needs amendment. Instead of the exceptional intervals being such that $\Sigma \int_{I_n} \frac{dr}{r}$ is finite (which is obviously meaningless in this case), we should have naturally $\Sigma \int_{I_n} \frac{dr}{1-r}$ is finite. $\left[\text{Note that } \int_0^1 \frac{dr}{1-r} \text{ is divergent.}\right]$ With this definition of the exceptional intervals the second fundamental theorem assumes the following form in this case:

$$\text{II}\ (q-2)\ T(r) \leqslant \sum_1^q N(r, a_\nu) - N_1(r) + 0$$

$$[\log T(r)] + (1 + \epsilon) \log \frac{1}{1-r}. \quad (\epsilon, \text{ any constant } > 0)$$

except in the exceptional intervals. We see

therefore that all our theorems, *viz.*, the theorems on defective values, unicity, multiple values, etc., remain the same *provided that* $\lim \frac{T(r)}{\log (1-r)^{-1}} = \infty$. It is already mentioned that in case this is not true the theorems need not be valid. Many of our theorems can be amended suitably if $T(f) = 0\left[\log \frac{1}{1-r}\right]$. We shall state and prove one such result. [See Ahlfors, *loc. cit.*] Suppose $\lim \frac{T(r)}{\log \frac{1}{1-r}} = p$. Then we prove that the total defect is at most $2+1/p$. [See Nevanlinna's tract for examples of functions possessing the preceding property.] Dividing $\overline{\text{II}}$ by $T(r)$ we obtain $(q-2) \leqslant q - \Sigma\,\delta\,(a_\nu) + \frac{1+\epsilon}{p}$, from which the result is at once apparent.

We close our lecture with one or two slight observations. There is no necessity for exceptional intervals in the case of meromorphic functions of finite order, *viz.*, in case $\frac{T(r)}{r^p} < \infty$ for a definite p. Now for all points which do not belong to the exceptional intervals

$\lambda(r) < [T(r)]^k . r^{k'}$. Suppose ρ is contained in an exceptional interval (a, b). Now $T'(r) = 0\,[r^{p+1}]$ obviously [as $T(r)$ is a convex increasing function of $\log r$]. And by a slight change we can adjust the exceptional intervals in such a way that $\Sigma \int_{I_n} r^{p+1}\,dr$ is finite. Now take an $r < \rho$, not belonging to any exceptional interval. Then

$$T(r) - T(\rho) = \int_\rho^r T^1(r)\,dr < k \int_\rho^r r^{p+1}\,dr.$$

Now we can so adjust r, in such a way that $T(r) - T(\rho) < M$ (independent of ρ). Now $\lambda(r) < [T(r)]^k . [r]^{k_1}$. But $\lim \frac{T(r)}{\log r} = \infty$. $\therefore r^{k'} < [T(r)]^\alpha$ for some α. $\therefore \lambda(r) < [T(r)]^\beta$ for some β.

$$\therefore [\lambda(\rho)]^{\frac{1}{\beta}} < [\lambda(r)]^{\frac{1}{\beta}} < [T(r) - T(\rho)] + T(\rho)$$
$$= T(\rho) + 0\,(1). \quad \therefore \log \lambda(\rho) = 0\,[\log T(\rho)].$$

We close the lectures with the remark that $T(r, f')$ is of the same order as $T(r, f)$ except in the exceptional intervals. This is too apparent if we put $f' = f . f'/f$ and apply II.

It is to be noted that we have unavoidably omitted many of the other branches of the subject. For a complete study the following books are recommended: (1) Valiron, *Lectures on the Theory of Integral Functions*, (2) Nevanlinna's tract, *loc. cit.* The latter is really a monumental book and also contains the bibliography till the year 1929.

Population Problem and Policy in India.

THE first Indian Population Conference was held at Lucknow on February 3 and 4, under the auspices of the Indian Institute of Population Research. A large number of delegates from the Universities, Provincial Governments and States attended. The Conference was convened by Dr. Radhakamal Mukerjee.

In his address of welcome to the delegates, Dr. R. P. Paranjpye, Vice-Chancellor, Lucknow University, emphasised the importance of the question of population in India in its quantitative, economic and biological aspects as underlying all sound progress. What the country wants, he observed, is a healthy vigorous population, every member of which should have a reasonable chance of living to a healthy old age and contribute to the general happiness of the people. For this, an adequate supply of nutritive food and other conditions of healthy life should be available to all, and the optimum population of a country should be determined by reference to these conditions.

In his inaugural address, the Hon'ble Mr. J. M. Clay, Finance Member, U.P. Government, traced how the pressure of population had been the motive power behind the innumerable migrations and incursions of the human race from prehistoric times. In Europe, we have Italy and Germany claiming the right to expand with their overflowing populations into Africa. In Asia, we find Japan following a similar policy towards China. In India itself, the rapid growth of population presents a problem serious enough to demand the earnest thought of her public men. At the last census of 1931, the population of the sub-continent was 352 millions; it has now increased to at least 370 millions; and unless some retarding factor impedes its natural progress, it will probably exceed 400 millions at the next enumeration in 1941. Indeed, it is not impossible that India may, before the 20th century is much more than half way through, have to support a population equal to that of China. These are staggering figures; they connote problems of the first magnitude for Government and for every thinking man.

Prof. Radhakamal Mukerjee, in the course of his address as convener, discussed at length the problem of India's population capacity. Prof. Mukerjee estimated that India's present food shortage was 48.4 billion calories and the present number of average men estimated without food in India, assuming that others obtained their normal daily ration, was 6.6 millions. India had 162 acres of waste lands which might grow food under an unremitting population pressure, but this could not increase the country's population capacity beyond 441 millions of persons.

Reviewing the growth of population in the country during the last 64 years, Prof. Mukerjee

stated that from 1871 to 1935 it increased from 206 millions to 373 millions and threatened to number 400 millions by the next census year.

By 1931, India's present population capacity was overstepped and just before the end of a quarter of a century, assuming that the present rate of increase continued, India would overstep 441 millions—the ultimate population capacity under the existing farming and living standards and industrial conditions of the people.

Recent movement of prices, especially of agricultural produce, had compelled, and would compel more and more of even the well-to-do peasants, to reduce their standard of living.

Modern education, medicine and public hygiene have reached the Indian village, and, as these spread more, birth-control will shock people less and an "adaptive fertility" will relieve the present heavy population pressure.

It is only when the fertility of India's work-a-day millions becomes somehow adapted to the present situation of definite and increasing food shortage, through their forethought and new attitude in the matter of the family, that India can look for a fresh advance of improved agriculture, education and mass sanitation in her villages. These will be followed up as in the West by a reduction of mortality and increase of average longevity, and thus, as more and more of human fertility is left to lie fallow, there will be an enrichment of life, its equipment and experience from all sides.

Vital Statistics Section.

In his presidential address before the Vital Statistics Section of the Conference, Prof. K. B. Madhava of Mysore University pointed out the defects and absence of registration of various aspects of demography, such as birth and death, sickness, marriage, fertility, dependency, etc., and advocated that small areas may be selected and the registration of statistics may be arranged in these by the labour department, by municipalities or universities. Without adequate data we cannot get correct pictures of society and the changing conditions in these. Anthropometric measurements might also be undertaken by medical colleges and public health programmes might be formulated in lines with their findings. Insurance companies in India may, as in some countries of the West, carry on researches into disease and co-operate with public health agencies.

In an important paper on the forecasting of population growth in India, Prof. K. K. E. Raja estimated that unless some untoward event, such as a large-scale famine or epidemic, occurred, the population of British India will be likely to approximate 400 millions in 1941. The favourable age composition of the married female population in India and the increase of their reproductive period, the decline of the death-rate, and other biological factors indicate that we are fast moving towards the 400 millions.

A paper by Mr. Murli Dhar Joshi of Allahabad University showed cyclical variations of birth and death-rates indicating periods of 3.6, 5.6 and 11 years.

Dr. Radhakamal Mukerjee added that this entirely agreed with his findings of a correspondence of droughts and famines in Northern India with sun-spot occurrence which therefore initiated in some measure rainfall, vital and economic cycles in India.

Dr. Cristopher Tietze, a physician of Vienna, submitted a paper which showed the inaccuracy of registration of births and deaths and the resulting under-estimate of birth-rate and death-rate by a large margin.

Dr. H. D. Mathur showed by means of some interesting diagrams the relation between overcrowding and chronic house shortage in Lucknow with tuberculosis and respiratory diseases.

Prof. Adarker's paper on the trend of population elicited a lively discussion towards the conclusion of this session.

Diet and Nutrition Section.

The dangers to the rice-consuming people of India from eating polished and parboiled rice were stressed by Dr. Nilratan Dhar, speaking on "Food and National Efficiency" in his presidential address before the Diet and Nutrition Section of the Indian Population Conference. He emphasised the need of State intervention in this matter and urged for the rationalisation of agriculture to ensure the supply of food for the poor being upto the standards required for health.

Dr. Radhakamal Mukerjee in a paper stressed that industrial workers in India were accustomed to more varied and more adequate dietary in the cities than the peasants in the villages. On the other hand, the calories at which the Indian working man's dietetic position ordinarily stood were much less than the British dietary level. This was responsible not only for lower weight, less stamina and more apathy, but also for the less strenuous work which could be done.

The results, he added, of investigations of the specific effects of nitrogenous foods on hard work might contribute materially to the increase of industrial efficiency. The co-operation of physiologists, psychologists and economists was essential in order to analyse and control all the factors which govern both the speed and volume of production in the country.

Dr. W. Burridge, discussing the calorie requirements in India, stressed the differences due to climatic factors. No workman can work without enough nourishment. Over the greater part of the year, however, manual work in India is done in great heat, and to do work in relative comfort under such circumstances the build of body required is the build which he possesses. There is no evidence that the Indian labourer was ever better off than he is to-day. He is just a man with thousands of years of adaptation behind him.

Economics Section.

Presiding over the Economics Section, Dr. Radhakamal Mukerjee spoke on "Food Standards and Agricultural Practices" and stressed the needs of analysing food consumption and food values in India which was quite inadequate. There was also, he regretted, lack of precise information relating to weights of individuals taken in the fields, factories and workshops per individual.

On the basis of investigations of the basal metabolism, he proposed the following standards of calorie requirements in India: for Bengal and Southern India (rice and legume-eaters) 2,000 calories (proteins 50, fats 50 and carbohydrates 475 grammes) and for Northern India (wheat and legume-eaters) 2,400 calories (proteins 60, fats 60 and carbohydrates 475 grammes).

Throughout India, he proceeded, the food materials were determined by what the fields yielded under different conditions of climates and soil and irrigation as well as under heavy population pressure. In fact, the physical characteristics of the Indian peoples, their dietary and cropping were all governed by regional conditions.

A heavy burden of population causes a large and even wholesale substitution of wheat by barley and the cheaper millets as foods and a complete omission of animal products, fruits and vegetables. This causes unbalance in diets which is particularly characteristic of the poorer sections and communities in India. On the other hand, agricultural progress is measured by the use of the more esteemed cereals such as wheat and rice and absolute increase in cereal consumption. However greater may be the food value of animal products, the consumption of these cannot be easily increased as that of soya-beans, peas, etc., which may form a valuable addition to the dietary of the Indian cultivator under the existing farming organisation, adjusted as it is to a heavy population pressure.

Diseases due to mal-nutrition are quite well known in India. Apart from diarrhœa, dysentery, beri-beri, epidemic dropsy, etc., the higher incidence of leprosy in the South, West and East of India has probably a nutritional basis. The increase of leprosy in the rice tracts of Northern Orissa, South-Western Bengal, Deccan and Madras is perhaps connected with the exhaustion of soil and deficiency of food values of rice grains. With an increase of population pressure on the soil, deforestation has gone on for decades and this has also contributed in no small measure towards the lowering of housing conditions in villages by making the supply of timber and bamboo scarcer and scarcer.

Such is the low standard of living that family budgets of peasants and industrial workers, collected from different parts of India, do not show the expected increase of percentage in expenditure on clothing, bedding and utensils with an increase in income. Mal-nutrition, illiteracy, sickness and high mortality all create a vicious circle, while slow industrialisation and absence of opportunities for emigration make an escape impossible.

Mr. D. P. Mukerji discussed the logical validity of the concept of Optimum as representing a standard towards which present economic conditions are ideally related.

Mr. B. N. Ganguly of Delhi University, pointed out that in an area of congested population, there is a great need of agricultural planning and of a balanced development of industry and agriculture based both on food and commercial cropping.

In a paper based on intensive investigation on the cost of living of the industrial labourers of the U. P., Mr. S. P. Saksena found that the average quantity consumed was less than the jail diet by at least 1 *chattack*, and that it was also inferior in quality.

SOCIOLOGICAL SECTION.

Professor Benoy Kumar Sarkar, in his presidential address to the Sociological Section of the Conference, pointed out that India's output in the sciences of sociology and population as developed in modern times was very modest. In neither field was it possible for anybody to make a debut to-day on the foundation of settled facts and universally accepted generalisations. The situation was on the contrary rather that of powerful controversies. One might speak of a virtual crisis in both these disciplines. Never was the necessity for avoiding any unstinted and unthinking alliance with one or other of the warring schools of systems of sociology and demographic thought more profound than to-day. At the threshold of the first Indian Population Conference, which happened also to be the first Indian Sociological Conference, it should be reasonable, he said, to maintain a thoroughly objective and critical attitude in regard to the prevailing "isms" and policies. In conclusion he put forward a strong plea for rationalisation of demographic distribution.

Speaking on the Dysgenic Trends of the Indian Population, Dr. Radhakamal Mukerjee stressed that, in India, for several decades, the intellectual social groups on account of such dysgenic customs like rigid hypergamy and endogamy as well as of a natural paucity of females, are showing either smaller natural increases or actual diminutions, as in the United Provinces. On the other hand, the less literate and backward social groups are more progressive demologically and these threaten to swamp the cultured stocks, especially in the prosperous areas in the Ganges plain. As in the West, the most fertile social strata in India are inferior but nowhere is the disparity between fecundity and culture greater than in Northern India.

FAMILY HYGIENE AND EUGENICS.

Problems of Marriage and Birth-Control were discussed before the Section on Family Hygiene and Eugenics. Dr. Khanolkar, in his presidential address, spoke on the biological evolution of marriage and the light it throws on contemporary Hindu marital life. He discussed particularly the inhibitions, which are such outstanding characteristics of the Hindu marriage, now being looked upon as tyrannies, as an investigation regarding the views on marriage of contemporary Hindu youths has indicated in Bombay. The new spirit of individualism will act on the mass of old ideas. It is the duty of scholars as well as leaders of social thought to give their serious consideration to the problem of marital adjustment in order that the features of an ancient institution, that do not fit in with the new social outlook, may be reconciled with the essential demands of stable marital relationship.

Prof. G. H. Ghurye read an interesting paper giving the results of his enquiry regarding 3,400 marriages amongst the Brahmin community from Kathiawar. He drew attention to the fact, by means of statistical analysis, that only about 12 per cent. of the marriages studied were completed families, *i.e.*, families in which the husband and the wife lived till the wife attained her 45th year. On an average, the duration of the marriages, that were broken as a result of the death of one of the partners, was five years longer than the average duration of the continuing marriages. The average fertility of a complete family was found to be a little over six, while the number of children surviving till the break of marriages per broken marriage was not even three. It was seen that of the males, who lost their

first wives, more than 70 per cent. did not re-marry and that those who re-married were generally young and had no children. The conclusion was clear that Hindu males did not re-marry light-heartedly.

In an interesting paper on marital adjustment in the changing social order, Dr. N. N. Sen Gupta emphasised that a programme of marriage reform must be based on a reconciliation of the ideal of romanticism, which is easily apt to mingle with a bare physical desire and the ideal of marriage as a sacrament. No doubt the practice of birth-control, which has come in vogue among the middle and richer classes of the society, prevents strain on the family income and the health of the mothers, but it also has encouraged casual sexual intercourse unmitigated by durable love or high ideal as well as an experimental attitude towards the partner.

This was followed by an interesting discussion on birth-control in which it was stressed by Dr. Radhakamal Mukerjee that, while the practice of birth-control is associated with the risks of an easy romanticism and loose sex life, which may themselves prevent the maturation of the sex sentiment representing, as it does, not an isolated drive but a wide variety of blended attitudes and interests, it is calculated, on the other hand, to re-integrate the diverse impulses which bind the partners when poverty, economic strain or the health of the mother threaten to sunder them. Thus birth-control may contribute towards both marital stability and unstability, according to the attitude, education and culture of the partners.

ANTHROPOLOGICAL SECTION.

In a comparative survey of the vital and economic conditions of the primitive races in India, in his presidential address before the Anthropological Section of the Indian Population Conference, Dr. Panchanan Mitter of the Calcutta University showed the dangers arising from the primitives being taught by missionaries and others to despise themselves and their own religion and tribal system while their economic transformation had not been commensurate to meet their newly acquired needs.

He pleaded for the following "safeguards" when the primitives under the new constitution would be dissociated and taken out from the midst of a system in which they have survived: (1) A competent anthropologist should be in charge of the primitive areas. Missionary zeal should be carefully watched and kept under control. (2) The economic cycle of the primitive area should also be carefully observed and economic development fostered and guided in keeping with this cycle. (3) The tribes should be protected against the unscrupulous money-lender and the landlord by special legislation, while the socio-economic relations between them and the surrounding civilised people should be regulated to promote assimilation in gradual stages of the tribal system to the politico-economic system of the rest of India.

Dr. D. N. Mazumdar, of Lucknow University, mentioned cases of a large number of tribes who were dying out. The *Korwas*, for instance, were becoming extinct like the Andamanese. Similarly, the Gonds and Bhils had enormously declined. Among the causes of decline or extinction of primitive tribes, Dr. Mazumdar mentioned the operation of stringent forest laws, the decline of charcoal-making and the administration of inappropriate excise laws and regulations.

In his concluding address before the Indian Population Conference, Prof. Radhakamal Mukerjee stressed the urgent need of a sane population policy in India. The population problem was not one of mere food supply—for a programme of removal of illiteracy and of sanitation was deferred or baffled, because population outran the capacity of education and sanitation.

On the other hand, proceeded Prof. Mukerjee, mere increase of production could not solve the problem now inherent in the situation, such as too low a standard of living, too high a proportionate cost of labour and crop yields which should be increased. Unless some check was placed on population growth, any other remedy tended to be only temporary; for, population would rapidly rise again to the maximum number of persons the land could support.

Prof. Mukerjee held that the days of large-scale irrigation projects, expanding cultivated areas, were also over in India. Industries, again, had progressed at a slow pace, while planned colonisation and inter-provincial migration had drawn little attention. He, therefore, emphasised the need of systematic crop and food planning, which should be undertaken by Government. India's minimal requirements for the congested population would, he thought, be covered by an increase of the production of peas, grams, pulses and oil-seeds, which would no doubt expand in substitution of grain. It was in this direction that India's subsistence farming could be adapted, as in China and Japan, to meet her chronic food deficiency and distribute the labour of the peasant family to better advantage throughout the year. Without a judicious combination of food and money crops and a balanced economy of agriculture and industries, population pressure would continually tend to produce a chronic mal-nutrition and lower the standard of living of the masses.

It was a strange paradox in India that, as the social scale was descended, the fertility increased but the survival value diminished. The survival value of the agricultural castes was exceedingly low in India and poverty, illiteracy and low survival value went together.

"The problems of Indian population," concluded Prof. Mukerjee, "are thus not merely economic. These are problems also for social reform, education, sanitation, eugenic and even of religion. Economics, ethics, religion and scientific humanitarianism all should co-operate in solving the various problems of over-population and mis-population in the country."

The work of the Indian Institute of Population Research, whose headquarters will be at Lucknow, has been divided among a number of standing committees working in various centres, namely, on population biology at the Bombay University under Dr. Ghurye, population hygiene under Prof. Raja at the Calcutta School of Tropical Hygiene, anthropological problems under Dr. Panchanan Mitter at the Calcutta University, population statistics under Prof. Mahalanobis at the Indian Statistical Institute and population economics under Dr. Radhakamal Mukerjee at the Lucknow University.

The next session of the Population Conference would be held in Bombay after two years.

Science Notes.

A Prehistoric Iron Implement from Malacca.—At the ordinary meeting of the *Asiatic Society of Bengal,* held on 6th April, Mr. Johan van Manen exhibited an iron implement, sent by Dr. P. V. van Stein Callenfels, the Dutch archæologist, who wrote, "from time to time a peculiar iron implement is found in the Peninsula of Malacca concerning which no one knows the use or manner of application. The Malays call it *Tulang mawas* which means 'bone of orang-utan'. They say that in olden times there lived large apes with iron bones and an iron spur at the elbow, and that this is what constitutes the implement.

"In connection with the find spots, I have always supposed that it may have been an old type of miner's instrument used by early tin miners. It is not, however, clear to me how that should have been.

"A short time ago, whilst investigating a few so-called 'slab graves', graves built up out of stone slabs, which are an offshoot of the megalithic culture occurring in the Malay Peninsula, in Southern Sumatra and in Java, we found an appreciable collection of such instruments which make it clear that they are connected with the slab grave builders, and have been probably introduced by them.

"These slab graves are found along the rivers running into the Strait of Malacca and are therefore evidently relics of immigrants who moved inland along these rivers, perhaps searching for tin. In my opinion, the mining hypothesis is therefore not without foundation. I believe to discern a certain Indian influence exercised at the end of the pleistocene, upon this part of Further Asia, but after this all Indian influence ceases and everything is here derived from south-west China, *via* Siam.

"These slab graves, which I feel inclined to date about the beginning of the Christian era, bring us for the first time again the Indian influence which soon expands widely and leads to Hinduisation of Sumatra, Bali, Indo-China, and so on.

"If this be the case, the iron instrument must have an Indian origin and there may be a possibility that India may bring a solution of the questions as to for what purpose and how it was used."

Other exhibits shown and commented upon at the meeting are: (1) Three small brass images from the Chittagong District—Dr. Ramaprasad Chanda. (2) Kharidat al-Qasr—M. Hidayat Hosain.

Dr. N. C. Sen Gupta gave a paper on "Putrikaputra or the appointed daughter's son in ancient law."

Mr. Everett H. Rankin and Mr. John Campbell White were ballotted for as ordinary members of the Society.

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Indian Chemical Society.—At the ordinary meeting of the Society, held on the 24th March at Calcutta, Dr. B. C. Guha delivered a lecture on Vitamin C. Rev. Father J. van Neste, S.J., presided.

The following gentlemen were admitted and elected as Fellows:—

Admitted.—Mr. G. Narayan (Bangalore): Dr. Chittaranjan Barat (Calcutta); and Mr. Birendra Nath Maitra (Calcutta).

Elected.—Mr. Dilip Kumar Banerji (Calcutta): Mr. Santi Ranjan Palit (Calcutta); Mr. Dhirendra Mohan Mukherjee (Barisal): Mr. Kanai Lal Roy (Calcutta); Mr. K. S. Venkat Raman (Benares); Mr. Dhirendra Nath Majumdar (Benares); Dr. Surendra Nath Ray (Calcutta): Mr. Jagannath Gupta (Calcutta); Mr. Sachindranath Datta (Gwalior); Mr. G. P. Pendse (Gwalior); Mr. K. V. Giri (Bangalore); Prof. S. D. Arora (Jodhpur); Dr. Umaprasanna Basu (Calcutta); and Prof. S. N. Bose (Dacca).

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Institution of Chemists (India).—The annual meeting of the Institution was held at the University College of Science, Calcutta, on the 29th February. The annual report which we have received gives an account of the activities during the year 1935. The Institution lost two members (Mr. H. Cooper, Ph.C., F.C.S. and Mr. J. N. Sinha, B.SC., M.SC., A.I.C.) by death, and one member by resignation; thirteen new members were elected. Seven ordinary meetings were held for reading and discussion of papers which have all been published in the *Proceedings of the Institution* (Quarterly).

In the course of his Presidential Address, Prof. H. K. Sen dealt with some aspects of industrial research and industrial development. After discussing certain vital questions, such as industrial co-ordination, standard of living, survey of natural resources, etc., he proposed that under the auspices of the Institution a "machinery composed of representatives, financiers, experts, engineers and such others to study and organise methods of industrial development, be created without loss of time, as the first instalment towards the solution of the unemployment problem. This body with the advantage of its experience, should be able to give a unique impetus to India's industrial regeneration. I make bold to propose, further, that our Institution should take upon itself the task of a bureau of industrial information and be in active co-operation with bodies, private or government, with similar aims. In fact, such a new orientation of our activities would constitute a distinct step in the right direction." Prof. Sen indicated an immediate solution of the unemployment problem of the educated classes. He said, "if a group of villages, five, ten or twenty, according to population and produce, would take it into its head to employ half a dozen educated young men to look after its sanitation, education, drinking water, milk and other food products, road-making, mosquito-killing, etc., out of no other sense than to increase its efficiency, I have no doubt the present unemployment would disappear in no time."

The following members have been elected to the Council:—*President*: Dr. H. K. Sen, M.A. D.SC., D.I.C.; *Vice-Presidents*: Mr. N. Brodie, Dr. E. Spencer, Dr. T. S. Wheeler, Mr. N. N. Sen Gupta, Rao Sahib M. N. Ghose, Mr. J. R. H. Bartlett; *Hon. Secretaries*: Mr. S. N. Sinha and Dr. M. N. Goswami; *Treasurer*: Mr. K. B. Sen; *Members*: Mr. J. K. Adhya, Mr. T. S. T. Chari, Mr. D. S. Naidu, Dr. S. G. Chowdhuri, Mr. Ronald

Alcock, Mr. Satya Prosanna Sen, Dr. Haridas Sen, Mr. P. K. Das Gupta.

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Indian Institute of International Affairs.—For the purpose of scientific study of international affairs, an organisation called the Indian Institute of International Affairs was inaugurated by H. E. Lord Willingdon on March 3rd. This is the Indian branch of the Royal Institute in London, which was started 16 years ago. The parent body has a valuable collection of books, and collects, examines and distributes international information. Commander Stephen King Hall, Official Representative of the Royal Institute, came to India to assist in the formation of the Indian branch. The Institute is strictly non-political in character.

In the course of his speech, H. E. The Viceroy said, "The growing interest of India in international quarters is the justification for the step that we are now about to take. Accurate information is most necessary on various issues which now dominate the international situation and by which India is affected, and this is one of the services which the proposed Institute will provide."

H. E. The Viceroy of India is the Hon. President of the Institute.

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The Madras Science Club.—The first annual report of this interesting institution, recently started in Madras, states, that it owes its existence to the initiative of Mr. K. S. Varadachar, who, it should be acknowledged, was actively associated with the foundation of *Current Science*. The Club was founded mainly to promote social amenities among the scientific workers in Madras and the report records a session of useful work. Prominent scientists in Madras are associated with the Club which, we hope, will continue to fulfil the purpose, for which it has been organised, in an increasing measure.

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The Roerich Central Asiatic Expedition for Drought-Resisting Plants.—The United States Department of Agriculture has sent an expedition to scour Central Asia in search of drought-resisting pasture grasses, for use in reclaiming drought-made desert land in the United States. On the edge of the Gobi desert in Central Asia, are great pasture lands where the summer temperatures often go above 100° and the winter temperature more than 40° below zero. The rainfall in the area is less than 16 inches annually, but apparently there are certain pasture grasses which, through thousands of years of natural selection, have adopted themselves to severe environmental conditions. Besides drought-resisting pasture grasses, the explorers hope to discover grasses and shrubs with root stocks of a type suitable for preventing arid and water erosion in dry land areas.

Prof. Nicholas de Roerich, the eminent Russian Archæologist, painter and leader of culture, is in charge of the expedition to the Hingan Mountains and the plains adjoining the Gobi. Prof. Roerich is a recognised authority on Central Asia, having made expeditions into Sikkim, Kashmir, Tibet, Chinese Turkestan, Mongolia, the Gobi Desert and the Altai Mountains. He is ably assisted by his son, Dr. Georges de Roerich, who possesses expert knowledge of the Central Asiatic tongues.

Numerous species suitable for transplantation in America have already been collected. More than 350 lots of seeds have been despatched to the United States Department of Agriculture for trial; while in Mongolia, a number of samples of soil have also been collected and despatched. According to a report appearing in the *Penang Gazette* (8th Oct. 1935), Prof. Roerich alluded to a recent project to re-afforest the mid-western plains of America, or as an alternative to plant a thick belt of trees running in a straight line north and south, so as to keep the fertile plains of the east, free from sand blowing over from the west.

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Expedition to Japan to Observe the Total Solar Eclipse.—The Government of India have sanctioned the deputation of Dr. Royds, Director of the Kodaikanal Observatory, to Japan to observe the total eclipse of the sun on June 19th, 1936. Dr. Royds is taking with him from Kodaikanal what is probably the most powerful spectrograph ever used at an eclipse. In Japan he will join up with the expedition under Prof. F. J. M. Stratton organised by the Royal Society and the Royal Astronomical Society.

The totally eclipsed sun exhibits certain appendages, which cannot be seen at any other time, and these afford clues to the constitution not only of the sun but also of those stars which are known to resemble the sun. Two different atmospheres of the sun become visible to the naked eye, *viz.*, the olive green corona with its streamers and the rosy red chromosphere with its prominences, while with special instruments a still lower atmosphere can be studied.

The Kodaikanal Observatory Expedition is especially to study how the wavelength in different parts of the sun's disc is affected by the scattered light from other parts of the disc. Another problem with which the expedition is concerned is the more exact determination of the wavelengths of the chromospheric lines; it is hoped to reach an exactness never before achieved. The expedition is also interested in the appearance of the oxygen lines in an eclipse, since the successful observations of these lines without an eclipse has recently been made at the Kodaikanal Observatory (*cf.* Communication by Drs. A. L. Narayan and T. Royds, published under *Letters to the Editor* section in this number).

About a ton of instruments will be carried. Mr. Marsden, a science teacher in a Missionary College at Nagercoil, is making his own way to Japan, primarily for sight-seeing, and will help the expedition in the management of the arc-lamp.

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Drug Control in India.—Mr. B. D. Amin, Managing Agent and Director, The Alembic Chemical Works Co., Ltd., Bombay and Baroda, has recently issued a pamphlet which draws pointed attention to the urgency of enacting a Drug and Pharmacy Act, not only for protecting public health, but also for safeguarding the indigenous pharmaceutical industry. In an editorial note appearing in a recent number of this *Journal* (*Current Science*, 1935, 4, 368–369) we have referred to the menace of drug adulteration and of traffic in spurious drugs. The proposals made by the Drug Enquiry Committee are admittedly adequate, but so far no effective legislation appears to exist for bringing about

a uniformity of control throughout India. Lt.-Col. R. N. Chopra's learned contribution on "Drug Adulteration and Spurious Drugs in India", which has been reproduced from the *Calcutta Medical Journal* and appended to the pamphlet, covers in a short compass, the salient points of the question and makes an eloquent plea for the enactment of adequate legislative measures.

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Problems of the Jute Industry.—Far-reaching recommendations for the development of the Jute Industry are contained in a report by Dr. S. G. Barker, who recently came to India to examine the scientific and technical development of the Jute Industry on behalf of the Indian Jute Mills Association. A comprehensive research scheme, estimated between £25,000 and £30,000 a year, has been proposed for research, covering experimental work, intelligence service and the provision of an information department. According to Dr. Barker, these activities must be entirely controlled by the industry and be an integral part of its structure. The complete autonomy of the Indian Jute Mills Association in this matter is essential. The Central Laboratories should be situated as near as possible to Calcutta, as most of the research will have to be developed under mill conditions. Dr. Barker's plan is designed to maintain the present market, recapture lost markets and gain new ones. According to an account appearing in *Statesman* (March 3, 1936), the report points out that "competitive materials have adopted scientific methods of cultivation, extraction and control in manufacture. The advance of science in other industries, both competitive and consuming, will accentuate the jute-marketing problem. The competitive commodities by their scientific origin are capable of modification to suit specific uses. Jute must also be able to do this by the establishment of an organisation to study ways and means of conferring upon either fibre or fabric characteristics which they do not possess in the ordinary natural condition." The function of science, therefore, will be to permeate throughout the jute industry a new and additional vista of its technique and scope, thus extending its uses and augmenting its rates of production per man-power. The report comprises a masterly survey of the problem and sets out a scheme of research commensurate with the needs of a growing industry.

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A tiny wanderer of the sky, which might be considered either a comet or a minor planet, has been re-sighted by telescopes (*Science*, Feb. 21, 1936, *Supp.*, 6). It is the Delporte object first seen in 1932. It has the distinction of making the second closest approach to the earth of any such comet or planet. Its magnitude is 13, according to the Harvard College Observatory reports, which means that it is possible to see it only with large telescopes. It is located somewhat west of the constellation of *Leo*. The Delporte object is also known by the name of *Amor* and its number among the minor planets is 1221.

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New Magnetic Alloy.—Research on the part of Canadian General Electric has resulted in a new, very powerful, permanent magnet alloy which will enable small motors and various control devices to use permanent magnet fields at a much lower cost and with greater simplicity of design (*Canadian Chemistry and Metallurgy*, Feb. 1936, **50**). The new alloy, which is named *Alnico*, is usually a cast material finished to shape by grinding and was first developed to resist scalding and deterioration at high temperatures. A heat-treating process has now been perfected by which its magnetic qualities are fully developed.

Only a few years ago an alloy of iron, aluminium and nickel was found to possess suitable permanent magnetic qualities. This alloy contains no carbon and belongs to the precipitation-hardening class alloys, quite distinct from the steel. The addition of cobalt was the step that produced the new *Alnico*, which has a specific gravity of 6.9, and is non-corrosive but brittle. It is said to have a higher coercive force and a lower residual induction than any other. The maximum available energy is higher and occurs at a lower flux density and a higher demagnetising force. Magnets of the alloy therefore require a higher force to completely magnetise them, and are less subject to demagnetisation by stray fields, high temperatures and mechanical vibration.

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A New Skin Germicide.—It is reported (*J. Soc. of Dyers and Colourists*, Feb. 1936, **61**) that a new skin disinfectant, possessing 350 times the power of alcohol and thrice that of tincture of iodine, has been introduced in the United States. It is stated that the product contains 50% of ethyl alcohol, and varying amounts of acetone, mercuric chloride, hydrochloric acid, chrysoidine Y, and distilled water. The dye used, besides having antiseptic properties, is said to fade out in 24 hours. The alcohol assists in the penetration of the mercuric chloride, the acetone removes fat from the skin, and the acid increases the germicidal activity of the mercuric salt.

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New Provinces in India.—The inauguration on the 1st April of two new Governor's Provinces, Orissa in the south-east and Sind in the north-west, marks an event of momentous significance to India. The two Provinces make well-defined linguistic areas and are clearly geographical units. The Nehru Report gave prominence to the desirability of amalgamating the Oriya-speaking tracts of Madras, Central Provinces, Bihar and Bengal into a separate province under a Governor, as this unification will be conducive to the cultural and industrial development of the Oriyas. The geographical isolation of Sind from Bombay, the linguistic differences between the inhabitants of Sind and of Bombay and the persistence with which the Sindhis urged for a separate province, make out a clear case for the separation of Sind from Bombay. Sir John Hubback and Sir Lancelot Graham have the unique distinction of being the first Governors of Orissa and Sind respectively.

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It is understood that the Government of India have under consideration the question of establishment of additional seismological laboratories in the country.

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The Imperial Council of Agricultural Research has constituted two Standing Committees on Rice and Wheat which will consider all matters

pertaining to "the production, marketing and general improvement of the two crops".

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Lt.-Col. G. Covell will officiate as Director of Malaria Survey, India, *vice* Lt.-Col. J. A. Sinton, granted eight months' leave.

* * *

Mr. L. M. Statham has been appointed Director of Public Instruction, Madras, in the place of Mr. H. F. Saunders, proceeding on leave.

* * *

Sir C. V. Raman, KT., F.R.S., N.L., has been elected Honorary Member of the Royal Irish Academy in the Department of Science.

* * *

Khan Bahadur Mian M. Afzal Hussain, Principal, Punjab Agricultural College, Lyallpur, and Entomologist to the Punjab Government, is representing India at the International Locust Conference which is being held at Cairo this month. The Khan Bahadur intends to tour in Europe after the Conference to visit the various agricultural colleges and research institutes.

* * *

Mr. Har Dayal Srivastava, M.Sc., Helminthologist, Imperial Institute of Veterinary Research, Muktesar (Kumaun), was elected an Ordinary Member of the National Academy of Sciences, India.

* * *

Spolia Zeylanica (*Ceylon Journal of Science.*)—Part 3, Vol. 19 of the *Ceylon Journal of Science*, contains, besides other articles, a series of interesting papers on some fishes, reptiles and mammals of Ceylon. Mr. Deraniyagala has contributed papers on fishes from Ceylon, the post-natal changes in the leathery turtle, Dermochelys, comparative study of Caretta and on a new crocodile. Affinities of Lorisoids and a survey of the distribution of mammals are contributed by Osman Hill and W. W. A. Phillips, respectively. With regard to the new crocodile, Deraniyagala notes that according to Boulenger, the Indian crocodile has the dorsal scutes arranged in four longitudinal series, the median ones being the biggest. In the Ceylon form, six longitudinal rows are present and the scutes are sub-equal. Moreover, the Ceylonese form is noticed to infest fresh-water while the Indian ones is "usually, if not always, above the limits of salt water". The extra peninsular form is named *Crocodilus palustris kimbula*, sub. sp. nov.

Osman Hill, in dealing with the affinities of the Lorisoids, reviews briefly the anatomical characters of all the systems of the Indian slender Loris and compares them with those of Lemur, an inhabitant of Madagascar. He concludes after a careful discussion that the Lorisoids are more closely allied to Tarsioids. The common characters, however, between Loris and Lemurs, are probably due to the retention of primitive mammalian features or to a parallel evolution. Following this line of thought, Hill introduces a new classification where the Haplorhine sub-orders, Anthropoidea, Pithecoidea and Tarsioidea, are treated as equal to the sub-orders of Strepsirhiæ, *viz.*, Lorisoidea, Lemuroidea, Chiromioidea and Cæciliolemuroidea.

* * *

Spectrographic Outfits for Metallurgical and General Chemical Analyses.—Seventh edition. January 1936. Adam Hilger, Ltd., 98 King's Road, London, N. W. 1. 60 pages. Illustrated. Post free.

This catalogue describes a new range of models of the well-known Hilger Quartz Spectrographs. These include the three instruments which are known all over the world as the small, medium and large models. All of them have been redesigned and take the Hilger Accessory Bar for the correct alignment of accessories. The large instrument is now offered in a fully automatic model, which is of great advantage in the industrial control of metals and alloys. A new size spectrograph has been introduced, intermediate in size between the small and medium, and therefore known as the Intermediate. An exceptionally complete range of accessories is described for both qualitative and quantitative analysis, including outfits for the Stepped Sector and the Lundegardh Flame methods.

Sound advice is given on the choice of apparatus for specific applications.

The six pages of names of users of Hilger Spectrographs are an interesting indication of the widespread use of spectro-analytical methods.

* * *

New Jena Glassware.—Laboratory workers and admirers of Jena glassware will be glad to learn that a new Jena glassware has been introduced under the title "*Duran Glass*" which combine the chemical characteristics of the Jena glassware with the resistance properties generally associated with Pyrex and similar class. The physical properties are :—

Coeff. of expansion, 3.6×10^{-6}; annealing temperature, 539° C.; Tenacity per gramme, 774° C. whilst the chemical properties are summarised by—loss of weight in mg. per decimetre square is 0.008 in water in 3 hours, 0.37 in 20% HCl and 147 in normal NaOH *plus* normal Na_2CO_3 at 100° C. This glass epitomises all the requirements of the laboratory. Stocks are being held by the agents —Messrs. Adair, Dutt & Co., Ltd.

* * *

Announcements :—

The Fifteenth International Congress of Medical Hydrology, Climatology and Geology will be held at Belgrade in October. Further information can be obtained from Prof. Milontine Neskovitch, 3 rue Takowska, Belgrade.

* * *

The Second International Congress of the Scientific and Social Campaign against Cancer will be held in Brussels on September 20–26, under the patronage of their Majesties the King and Queen of the Belgians. Further particulars can be had from the General Secretary, 13 rue de la Presse, Brussels.

* * *

Nature announces that the Third International Congress for Investigation of Light will be held at Wiesbaden on September 1–7, under the presidency of Prof. W. Friedrich, when discussions will be held on the biology and physics of light and treatment of light. Further information can be obtained from Dr. H. Schreiber, Robert Koch Platz 1, Berlin, N. W. 7.

* * *

At the invitation of the Society of Glass Technology, an International Congress on Glass will take place from July 2 to July 11, 1936. The meetings will be held for the most part in

London, while a few will be held also in Sheffield. The arrangements for the technical programme have been made by the International Commission on glass which was set up at Milan three years ago. Further information can be obtained from Prof. W. E. S. Turner, Society of Glass Technology, Darnall Road, Sheffield 9.

* * *

CORRECTIONS.

(1) In the letter: Roonwal, M. L., 1935. 'Fate of the Embryonic Membranes in Insects.'—*Current Science*, Vol. IV, No. 5, pp. 317–18, the insect, the fate of whose embryonic membrane has been described, is *not* the European Migratory Locust, *Locusta migratoria* L., but the African Migratory Locust, *Locusta migratoria migratoriodes* R. & F. Since definite physiological differences have been found between the two sub-species, it is obviously necessary to indicate one's material as exactly as possible.

I am indebted to Mr. B. P. Uvarov of the Imperial Institute of Entomology, London, for this correction.

M. L. ROONWAL.

(2) *Current Science*, 1936, 4, 656–657.—The contribution "A Modification of Dixon's Constant Pressure Respirometer" should have appeared under the joint authorship of B. N. Singh and P. B. Mathur. Only Dr. B. N. Singh's name has been mentioned. We regret the error.

* * *

We acknowledge with thanks the receipt of the following :—

"Bulletin of the U. P. Academy of Sciences," Vol. 6, Part I, February 1936.

"Actualites Scientifiques et Industrielles," Nos. 219, 249, 250–253, 256–259, 260–263, 265, 292–294.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Part 3, March 1936.

"Journal of Agricultural Research," Vol. 51, Parts 10–11, Nov.–Dec. 1935.

Department of Agriculture, Dominion of Canada, Bull. 2.—"Improved Market Type in Poultry Breeding Stock": Bull. 3.—"Farmers' Business Organization in Canada," 1935.

"The Philippine Agriculturist," Vol. XXIV, No. 10, March 1936.

"The Allahabad Farmer," Vol. X, No. 2, March 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4344–4348.

"Biochemical Journal," Vol. 30, Nos. 1 and 2, Jan.–Feb. 1936.

"Journal of the Indian Botanical Society," Vol. 15, No. 2.

"Communications from the Boyce-Thomson Institute," Vol. VII, No. 4.

"Journal of the Institute of Brewing," Vol. XLII, No. 3, March 1936.

"Chemical Age," Vol. XXXIV, Nos. 869–873.

"Journal of Chemical Physics," Vol. 4, No. 3, March 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 3.

"Russian Journal of General Chemistry," Vol. V (LXVII), No. 12.

"Journal de Chimie Physique," Vol. 33, No. 2.

"Experiment Station Record," Vol. 74, No. 2, February 1936.

"Transactions of the Faraday Society," Vol. XXXII, No. 3, March 1936.

"Indian Forester," Vol. LXII, No. 4, April 1936.

"Indian Forest Records—Vol. I, No. 12.—"Entomological Investigations on the Spike Disease of Sandal (26) Coccidæ (Homopt.)"

"Indian Forest Records—Vol. II, No. 1.—Shrinkage studies in Indian Woods I. Effect of high temperature on the shrinkage and moisture equilibrium of wood."

"Forschungen und Fortschritte, Vol. 12, Nos. 7–9.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. VII, Nos. 3 and 4.

Government of India Publications—"Monthly Statistics of Production of certain Selected Industries of India, Department of Commercial Intelligence and Statistics," Nos. 8 and 9.

Government of India Publications—Indian Meteorological Department, Vol. 6, No. 67.—"Measurement of Vertical Currents in the Atmosphere mainly of Thermal Origin with Pilot Balloons."

"Indian Trade Journal," Vol. CXX, Nos. 1551–1553 ; Vol. CXXI, No. 1554.

"Marriage Hygiene," Vol. II, No. 3, February 1936.

"The Calcutta Medical Journal," Vol. 30, No. 9, March 1936.

"Medico-Surgical Suggestions," Vol. 5, Nos. 2 and 3.

"Journal of the Annamalai University," Vol. V, No. 2.

"Annual Report of the Calcutta School of Tropical Medicine and the Carmichæl Hospital for Tropical Diseases," 1934.

"The Calcutta Review," Vol. 59, No. 1, April 1936.

"The Presidency College Zoology Magazine," Madras, Vol. 3, No. 5, 1936.

"Review of Applied Mycology," Vol. 15, Nos. 2 and 3.

"Journal of the American Museum of Natural History," Vol. 37, Nos. 2 and 3.

"Nature," Vol. 137, Nos. 3460–3464.

"Journal of Nutrition," Vol. 11, No. 2.

"Canadian Journal of Research," Vol. 14, Nos. 1 and 2 and Index to Vol. 13.

"Journal of Research," National Bureau of Standards, Vol. 15, Nos. 5 and 6.

"Ceylon Journal of Science," Section B.—Zoology and Geology, Vol. XIX, Part 3.

"Science and Culture," Vol. I, Nos. 10 and 11.

"Lingnan Science Journal," Vol. 15, No. 1, Jan. 1936.

"Scientific American," Vol. 154, Nos. 3 and 4.

CATALOGUES.

"Bell's Miscellany," Spring 1936 (G. Bell & Sons, Ltd.)

"New Books in General Literature," Spring 1936 (Edward Arnold & Co., Ltd.).

"Monthly List of Books on Natural History and Science," March 1936 (Wheldon and Wesley, Ltd.).

"Mitteilungen uber Neuerscheinungen und Fortsetzungen, Nos. 1 and 2" (Verlag von Gustav Fischer in Jena).

Academies and Societies.

Indian Academy of Sciences:

March 1936. SECTION A.—H. GUPTA: *On the Numbers of Ward and Bernoulli.* R. ANANTHAKRISHNAN: *Polarisation of the Raman Bands of Water and Deuterium Oxide.* The influence of temperature and the observed polarisation results could be satisfactorily explained by postulating that the liquid state is composed of a large percentage of polymerised molecules (dihydrol) with frequencies 3220 and 3430, and a smaller percentage of non-polymerised molecules with frequencies 3430 and 3600. D. R. DHINGRA, H. L. UPPAL AND K. VENKATARAMAN: *Antiseptics and Anthelminthics. Part II.—A Synthesis of 6-Benzyl-7-hydroxyflavone and 6-n-Hexyl-7-hydroxyflavone.* R. S. KRISHNAN: *Scattering of Light in Optical Glasses.*—The intensity and state of polarisation of light scattered transversely by a series of seventeen glasses of optical quality has been studied with the incident light in different states of polarisation. It is concluded that there exist molecular aggregates of size not small compared with the wavelength of light. B. L. GULATEE: *Gravity Formulæ in Geodesy; Their Precision and Interpretation.* A number of important gravity formulæ are discussed. N. W. HIRWE and M. R. JAMBHEKAR. *Derivatives of Salicylic Acid. Part IX.—Stability of the Sulphonic Acid Group in the 4-Sulphosalicylic Acid. Part I.—Nitration of 4-Sulphosalicylic Acid.*—Sulphonic acid group outside the directing influences of the –OH and –COOH groups cannot be substituted by the nitro group as in 3- or 5-sulphosalicylic acids. B. SUNDARA RAMA RAO: *Studies on the Anisotropy of the Optical Polarisation Field in Liquids. Part I and Part II.*—From a knowledge of the molecular refractivity at different temperatures, the anisotropic constants of the optical polarisation field are calculated in CS_2, C_6H_6 and C_6H_{14}. The polarisation field becomes more and more isotropic with increasing temperature. S. SIDDIQUI: *The Alkaloids of Holarrhena Anti-Dysenterica. Part IV.—The Occurrence of Two Further New Bases in the Bark of Indian Holarrhena and Their Relationship to Conessine and Holarrhimine.* S. SIDDIQUI AND R. H. SIDDIQUI: *The Alkaloids of Holarrhena Anti-Dysenterica. Part V.—Studies in Holarrhimine.*—Methylation, benzoylation and acetylation have been studied. N. W. HIRWE AND M. R. JAMBHEKAR: *Derivatives of Salicylic Acid. Part X.—Stability of Sulphonic Acid Group in the 4-Sulphosalicylic Acid. Part II.—Bromination of 4-Sulphosalicylic Acid.* H. J. TAYLOR AND V. D. DABHOLKAR: *The Tracks of the α-Particles of Thorium and its Products.*—Radiothorium atoms introduced into a photographic emulsion disintegrate *in situ*, emitting five α-particles in succession. In this way "stars" are produced, consisting of five tracks radiating from a point. E. GORA: *On the Theory of Pressure Broadening of Spectral Lines.*

March 1936. SECTION B.—M. K. SUBRAHMANIAM AND R. GOPALA AIYAR: *On the Possible Effect of the Environment on the Cytoplasmic Inclusions in the Oocytes and Oogonia of* Dasychone cingulata, Salmacis bicolor *and* Clibanarius olivaceus.—The remarkable diversity of results obtained by workers on the Cytoplasmic phenomena during Oogenesis in the same animal, is due to variations in the environment (1) seasonal and (2) geographical. P. M. GLOVER AND K. C. CHATTERJEE: *A Preliminary Note on the Bionomics and Economic Importance of* Microbracon Hebetor *Say, A Braconid New to North India.*—For the first time. *M. Hebetor* Say is recorded in Northern India and a preliminary description of the behaviour, and economic importance with particular reference to lac cultivation is given. I. FROILANO DE MELLO AND EMERCIANO DIAS: Plasmodium narayani *N.Sp., Parasite of the Fish Otter* Lutra lutra.—A plasmodid of a fish otter, found only in the blood and lung smears, has been recorded for the first time. J. S. PATEL, C. M. JOHN AND C. R. SESHADRI: *The Inheritance of Characters in the Groundnut,* Arachis hypogæa.—An attempt at a genetic analysis of the several characters—chlorophyll deficiency, abnormality, habit, branching, duration, hairiness, anthocyanin pigment in the plant and four seed-coat colours—of the groundnut, has been reported. Thirteen genetical factors are assumed for interpreting the results. M. B. MIRZA: *A New Species of the Nematode Genus* Dermatoxys *from* Lepus ruficaudatus.—The species described differs from the known ones of the genus *Dermatoxys* Schneider, 1866, necessitating the creation of a new species. B. N. SINGH AND G. P. KAPOOR: *Plant Growth in Relation to Partial Pressures of Oxygen.*—The dry matter production at any stage during the growth is the resultant of two variables: (1) the age factor and (2) the factor for oxygen. B. M. JOHRI: *Contribution to the Life-History of* Cedrus deodara *Loud.*—The development of the microspores and the pollen grains of this interesting Indian Conifer has been described. A. SREENIVASAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition.—Part XI.—Effect of Manuring on the Growth and Intake of Silicon by Dry and Wet Cultivated Rice.*—The beneficial effect of silicate fertilisation in field practice and the rôle of silicon in the nutrition of the rice plant have been discussed. YAJNAVALKYA BHARADWAJA: *On Two Forms of* Hydrurus *Ag. from Kashmir.*—Two forms of Chrysophyceæ have been recorded and described.

The National Academy of Sciences, India:

March 25, 1936.—MATA PRASAD AND B. V. MOHILE: *The Photo-Reduction of Ferric Chloride in Alcoholic Solutions in the Light of a Quartz Mercury-Vapour Lamp.* M. L. ROONWAL: *Sexual Dimorphism and Post-Embryonic Growth in* Dialeurodes dissimilis *Quaint. and Baker (Homoptera, Aleurodidea).* M. N. SAHA and A. N. TANDON: *A New Model Demountable Vacuum Furnace.* S. C. VERMA: *Studies in the Family Bucephalidæ* (Gasterostomata).—*Part II.—Description of Two New Species.* JAGRAJ BEHARI LAL: *Chemical Examination of the Fruit of* Physalis Peruviana *or Cape Goose Berry.*

Indian Chemical Society:

March 24, 1936.—DINES CHANDRA SEN: *Studies on Cyclic Thioketones. Part I.—Synthesis of Non-Polymerised Thiocyclohexanone, Thiocyclopentanone and their Derivatives.* N. M. BOSE AND S. R. MAITRA:

Investigation on the Effects of Humidity and High Temperature on the NH_2-content of Different Samples of Rice. DINES CHANDRA SEN: *Studies in the Camphor Series.—Part III.*

Indian Botanical Society:

April 1936.—A. C. JOSHI: *A Contribution to the Embryology and Cytology of* Rivina humilis *Linn.* V. S. RAO: *A Contribution to the Morphology of* Antigonon leptopus *Hook. and Arn.* B. S. NIGAM: *Physiology of Zonation.—Effect of Light and Temperature on Zonation in* Acrothecium lunatum *Wakker.* EDWARD BARNES: *Two Notes on South Indian Strigas.* K. P. RODE: *A Silicified Dicotyledonous Wood* Dryoxylon mohgaœnse *sp. nov. from the Deccan Intertappean Beds of India.* G. N. RANGASWAMI AYYANGAR AND V. PANDURANGA RAO: Sorghum popyrascens *Stapf.* D. P. MULLAN: *On the Seed Structure and Germination of* Acanthus ilicifolius *Linn.* MUKAT BEHARI RAIZADA: *Recently Introduced or Otherwise Imperfectly Known Plants from the Upper Gangetic Plain.*

Meteorological Office Colloquium, Poona:

March 10, 1936.—Mr. A. K. ROY summarised Col. Gold's Presidential address on "Fronts and Occlusions", delivered before the Royal Meteorological Society in January 1935.

University and Educational Intelligence.

Aligarh Muslim University:

The Degree of Doctor of Laws (*Honoris causa*) was conferred on His Excellency Lord Willingdon, Viceroy and Governor-General of India and Lord Rector of the University, at the Special Convocation, held on 22nd March. The Chancellor, H. E. H. the Nizam of Hyderabad, presided.

H. E. H. the Nizam announced a donation of Rs. 10,000 for the construction of a Pavilion in commemoration of Lord Willingdon's visit.

It is understood that Sir Azizuddin Ahmed donated Rs. 10,000 to the Aligarh Muslim University. A similar donation has been made by the Raja of Pirpur.

The Andhra University:

Mr. C. R. Reddy, M.L.C., was elected Vice-Chancellor of the University. The election was held on 28th March.

University of Madras:

Award of Research Degrees.—

D.Sc.—Mr. S. Gopalakrishnamurthy, M.A. (Thesis—"Atomic Energy States of Tellurium").

M.Sc.—Mr. N. Kesava Panikkar, B.A. (Hons.) (Thesis—"Studies in South Indian Brackish Water Actinarius"); Mr. P. K. Sesha Aiyer, B.Sc. (Thesis—"Absorption and Fluorescence Spectra of Organic Compounds"); Mr. T. K. Srinivasan, B.Sc. (Thesis—"Action of Sulphuric acid on Cotarnine; Action of Bromine on Narcosine, etc."); Mr. T. Varahalu, B.A. (Thesis—"Physical and Chemical Studies on Sugarcane Jaggery").

University of Mysore:

1. *Personnel.*—Dr. E. P. Metcalfe, D.Sc., F.Inst.P., Vice-Chancellor, has been granted leave for 27 days from the 5th March 1936, with permission to affix thereto the summer vacation, and Mr. N. S. Subba Rao, M.A., BAR-AT-LAW, Director of Public Instruction in Mysore, has been appointed to be in charge of the office of the Vice-Chancellor, in addition to his own.

2. *Special Convocation.*—A special Convocation of the University was held at Mysore on the 25th March 1936, for conferring the Honorary Degree of Doctor of Laws, on Rajasabhabhushana Diwan Bahadur Sir K. P. Puttanna Chetty, Kt., C.I.E., Retired Member of Council, His Highness the Chancellor presiding.

3. *Recognition of Examinations.*—The University of Calcutta has recognised the S. S. L. C. Examination of Mysore as equivalent to the Matriculation Examination of that University, subject to the condition that the holders of the certificate must be declared eligible by the University of Mysore for joining the University course before they are allowed to join a college under the Calcutta University and that they must also conform to the usual rules of migration.

4. *Election to the Mysore Medical Council.*—In the election held for returning a member from the Faculty of Medicine of this University to the Mysore Medical Council, Mr. B. K. Narayana Rao, B.A., M.B.C.M., M.R.C.S., D.P.H., D.O., Principal, Medical School, Bangalore, secured the highest number of votes.

5. *Meeting of the Senate.*—The Annual Meeting of the Senate was held on the 26th March 1936, at which the annual report and accounts for 1934–35 were adopted and the budget estimates for 1936–37 considered and passed, providing for a grant from the Government of Rs. 10.36 lakhs. A proposal intended to introduce changes in the mode of election to University authorities were vetoed.

Among other decisions arrived at, mention may be made of the following:—

(1) That candidates successful in the M.A. and M.Sc. degree examinations should be classed, the minimum for a First Class being 60% and that for a Second Class being 50%.

(2) That the Government of Mysore be requested to move the Government of India that in recommending candidates for appointment in the Secretariat and other institutions connected with the League of Nations in future, due consideration be given to deserving graduates of this University also, since so far no graduate of this University has been made the recipient of the honour of serving under the League of Nations.

Nagpur University:

At a meeting of the Executive Council of the Nagpur University, held during the last week of March, Sir Hari Singh Gour, Vice-Chancellor, who will be participating in the centenary celebration of the London University in July next, was granted leave of absence for four months. Subject to His Excellency the Chancellor's approval, Col. K. V. Kukday was appointed

Acting Vice-Chancellor, during Sir Hari Singh Gour's absence.

Inter-University Board:

The following among other resolutions were passed at the eleventh meeting of the Inter-University Board, held at Aligarh, which concluded on Wednesday, February 26. Mr. Littlehailes, the Vice-Chancellor of the Madras University, presided:—

That a committee consisting of Mr. R. Littlehailes, Sir George Anderson and the Hon'ble Mr. Justice Khwaja Mohd. Noor be appointed to select two candidates to be recommended for the award of Carnegie Corporation Grants.

That the Universities in India be invited to consider whether it is not desirable to adopt the Intermediate Examination in Science as the qualifying test for admission to the courses of study of Medical Degrees.

That appropriate departments of Government of India be addressed to include: (i) Natural Science in the list of subjects for all the Competitive Examinations from which they have recently been omitted; (2) Philosophy as one of the subjects for the Indian Audit and Accounts Examination, and Ethics and Psychology in the list of subjects for the Indian Police Service Examination.

That the Trustees of the Carnegie Foundation be requested to include Indian Universities in the scheme of the provision of thirty-six Fellowships, intended for displaced German scholars.

That the Government of India be addressed urging upon them the necessity of securing for Indian students, who are granted foreign scholarships, or Fellowships by the different Universities, a definite number of seats without premium in different industrial concerns of the various countries from which supplies are purchased by India, by making suitable conditions at the time of giving contracts.

That the Universities be requested to consider the desirability of including Nautical and Aeronautical instruction in the University curriculum.

That the invitation of the University of Nagpur be accepted with thanks, and the venue of the next meeting of the Inter-University Board be there.

Pandit Amarnath Jha of the University of Allahabad was elected Chairman for the year 1936–37. Dr. J. C. Ghosh of Dacca, Prof. Parija of Cuttack, and Dr. L. K. Hyder, Member, Public Services Commission, were elected to represent the Inter-'Varsity Board on the Imperial Council of Agricultural Research.

Reviews.

The Restless Universe. By Max Born. Authorised Translation by Wirifred M. Deans. (Blackie & Sons, London, 1935.) Pp. 278; price 8*sh.* 6*d.*

There is a good stock of popular literature on modern physics in the English language. Jeans and Eddington are almost household words. Entirely new ideas as well as difficult and abstruse subjects have been presented in lucid manner with the discipline of English style by these master minds. Nevertheless Max Born's *The Restless Universe* (authorised translation) may be called a new venture in this line considering the high ambition with which the author sets out and the wonderful manner in which he seeks to realise it. The reading of the book is a first-rate intellectual treat.

The book is divided into five chapters, each of about fifty pages, on the air and its relatives, electrons and ions, waves and particles, electronic structure of the atom and nuclear physics. The author starts with the simplest type of matter, *viz.*, the gas and explains its essential properties by introducing the Kinetic theory of the molecules which are really the main objects of study in the first chapter. The statistical idea is introduced almost at the very start preparing the reader for the shocking surprise awaiting him in the later portion of the work that "all laws of nature are really laws of chance in disguise". After describing how actual beams of molecules can be produced to hit a target and how their number can be measured, the subdivision of molecules, chemically into atoms, their classification, the periodic table of elements are all brought in one sweep and the first step in the journey for the quest of the ultimate source of matter ends. The reader then crosses a boundary into a new realm populated with electrical beings: electrons and ions. The physicists now develop some refined sense organs to feel the existence of, to see and even measure these new creatures. The reader is now acquainted with Wilson Chamber, Geiger-Müller counter, and knows the charge of the electron, its mass and even the highly ethical unitary doctrine of identity of Mass and Energy. Then he comes almost to the heart of the problem. The electronic world often sends messengers to the outside world of ours in the form of radiation and in turn receives such messengers from outside. The mystery then deepens. What is the relation of this messenger to the electronic population?

The messenger, light, plays a dual rôle. While journeying in the outside world it is a wave but in the dealings with the atomic population it behaves as a particle of energy. On entering the realm of electrical charges it can knock out an electron with great speed to the outside world. The dual rôle is then found to be not only a characteristic of the messenger but also of the electron. Electron waves can be actually made visible on the photographic plate. The reader is then reconciled to the idea that matter is wave and wave is matter. The difficult subject of wave mechanics, probability wave and its bearing on the principle of causality are introduced gradually, and the reader learns that to understand the behaviour of the creatures of the new realm of electricity, one has to sacrifice the outside world law of causality which, as the author hints, is probably only a habit of thought.

Then comes Bohr's description of the new world of atoms. The electronic population within an atom is in a mad whirl round a citadel of positive charge called nucleus. This whirl may be described in terms of moving particles which curiously are restricted only to certain discrete paths which can be constructed only by adapting certain processes patented by the German physicist Planck more than thirty years ago. This was really the beginning of the modern quantum theory. Alternatively, a description in which the electrons are divested of their individualities and are regarded as waves in a certain conceptual space is also possible. The waves can only tell us about the odds that an electron will be found in a certain place but it will be quite in vain to think of the motion of the electron with time. Both processes are useful in understanding the observed behaviour of the electronic world but the latter ultimately proves to be more powerful. A host of phenomena previously considered to be unconnected or very imperfectly understood, now find unification within the electronic world of the atom.

The journey across the electronic realm takes the reader first through an outer region which is the region of activity of chemical changes and whence the messengers are responsible for what are called optical spectra. The uplands are populated by electrons having more vigorous motion, and which send out more energetic messengers outside in the form of X-rays. Right up on the top is the citadel called nucleus. This is too strong to be penetrated by the ordinary means of the physicist. The history of the present-day advance in physics is really an account of the attempt by the physicists to storm the citadel.

The last chapter of the book describes the fundamental particles discovered by the bombardment of the nucleus, and the nuclear transformation which is a realisation of the dream of the alchemists of the Middle Ages by modern physicists (but not from a sordid spirit of lucre the author assures us). But here the reader is compelled to stop. The journey remains unfinished. Born's printer was once pleased to compose 'nuclear physics' as 'unclear physics,' and the author admits that the printer was not far wrong. For, after a successful journey over many an unknown and difficult region, the reader is now left on the citadel, the deepest centre of the material universe with the mystery wall still rearing its head proudly before him while off and on missiles sent from outside, or some of the inner population mysteriously leaking through the wall bring very valuable information to the physicists. But the reader finds there is no solid ground underneath him anywhere. Starting from the outside world, looking into the sub-world of molecules shows them to be in continual motion colliding with one another. The electronic world inside the atom is in a mad whirl which becomes wilder and wilder the deeper one penetrates into the atomic layers. Besides, to be able to understand the workings of these lower sub-worlds one has to sacrifice his cherished outer-world ideas of wave and matter and even of casual principle. But the quest goes on and it is earnestly hoped that the scientists' love of truth will one day put him in possession of the secrets of matter, so far as it may be within the grasp of the human mind.

A novel feature of the book is the film and there are seven of them. I confess I have not been very successful with some of them but realise they will prove interesting to many, specially to the young readers. There are a few inaccuracies in the book, for instance on page 45 the proportion of hydrogen to oxygen has been inverted and the same defect occurs again on page 47, line 7.

N. R. S.

Experimental Atomic Physics. By G. P. Harnwell, Ph.D. and J. J. Livingood, Ph.D. (International Series in Physics.) (Messrs.

McGraw Hill Publishing Co., London, 1933.) Pp. 472. Price 30*s*.

This volume of about 450 pages covers in a general way the whole field of modern physics considered from the experimental standpoint. The following are the main chapter headings:—(1) The Velocity of Propagation and the Pressure of Radiation, (2) Black-body Radiation, (3) The Atomicity of Matter and Electricity, (4) The Ratio of Charge to Mass of Electrons and Ions, (5) The Wave Aspect of Matter, (6) Thermionic and Photo-electric Effects, (7) Line Spectra, (8) Atomic Energy States, (9) X-Rays, and (10) Radioactivity. There are two very useful appendices, one dealing with instruments for measuring small currents and potential differences and the second describing vacuum technique. The treatment is sufficiently detailed to give the student a grasp of principles and at the same time a very fair idea of the technique of the fundamental experiments on which modern physics is based. The volume is to be heartily recommended to Honours students in Indian Universities and to their teachers who desire to have a text on which to base their lectures.

C. V. RAMAN.

Physikalische Methoden Der Analytischen Chemie. By G. Scheibe, H. Mark and R. Ehrenberg. (Akademische Verlagsgesellschaft, Leipzig, 1933.) Erster Teil. Pp. 388. Price Unbound 34 RM and Bound, 36 RM.

This volume deals in an authoritative and useful manner with spectroscopic and radiometric methods used in analytical chemistry. The authors are G. Scheibe, H. Mark and R. Ehrenberg who deal respectively with the use of the spectroscope, with X-ray methods and with the use of radioactive indicators for the purposes of analytical chemistry. As might be expected from the fact that the authors are specialists in the fields dealt with by them, the treatment of the subject is clear and thorough. Scheibe's article includes an account of elementary spectroscopic theory, the production of spectra, apparatus for recording and measuring spectra, and a detailed account of both qualitative and quantitative analytical methods with the aid of emission and absorption spectra. Mark's article similarly deals with the production of X-rays, X-ray spectroscopes, the systematics of X-ray spectra and with qualitative and quantitative analysis with the aid of emission, absorption and fluorescent X-ray spectra. Ehrenberg's article is the shortest of the three and is of special interest at the present time owing to the recent great development of radio-chemistry. The book is fully illustrated and contains extensive tables which should go far to make it a very useful handbook in the laboratory besides being an excellent text for theoretical study. The volume should be in the hands of every worker interested in the modern developments of chemistry.

C. V. RAMAN.

Electrical Engineering Economics. By D. J. Bolton. (Chapman & Hall, London.) 1935. Pp. 365; Price 21*sh*.

Engineering may in some respects be considered a branch of economics including mainly the science of utilising materials in the most economic manner consistent with safety.

The average engineering graduate in this country appears to possess little, if any, knowledge of Engineering Economics. In these days of fierce competition it is very necessary that more attention be paid to this important subject and Mr. Bolton's book should prove a most admirable treatise for arousing the interest of the student in economics and providing a good foundation to his education as an engineer. To the more experienced man it would be of value as a reference book. A feature of the book is the treatment of economics of consumption as well as production.

Part I deals in a clear and convenient manner with general economic principles involving capital, interest, depreciation, sinking funds, etc., which should be of particular value to the student. Depreciation is a complex and much discussed subject to-day and its application in actual practice, is more a question of policy and judgment than of accounting or mathematics. The chapters on depreciation discuss the various causes of depreciation, loss of value, and the fact that the physically useful life may be and usually is shortened by obsolescence, inadequacy and other factors. This together with the short chapter on economic productivity should awaken the interest of the student and engineer sufficiently to warrant a deeper study into such important subjects.

Chapter VIII is of special interest as it discusses the economic desirability in some

cases of operating machinery underloaded. This of course is difficult of application when motors of different manufacturers are compared as their design characteristics, tolerances for heating, etc., do not correspond, while the cost of losses as discussed later must be applied with caution.

Part II is mainly devoted to losses and their economic significance. Annual costs are an elusive study. Electrical engineering, economic formulæ and principles are generally applicable to generating plants operated by steam or oil engines where the expenses of generation are a big item in the "all in" cost of a unit. In such cases higher capital expenditure to reduce losses is more often justified than in the case of hydro-plants. The economic treatment is somewhat different. In the one case a definite and tangible value can be applied to the losses of a system having a steam or oil engined station, but it is not so easy in the case of a hydro-electric system. Larger losses are usually permissible unless it can be shown that such power could be sold.

Again in applying such formula, particularly maxima and minima, considerable judgment is usually necessary to decide if the mathematically correct result is a practicable proposition. Formulæ for the most economic penstock line for instance, may often give a thickness too small to be mechanically practicable or thicker than permitted by standard practice. Generally speaking, the use of economic formulæ provides excellent training for the young engineer but they should only be applied in practice by experienced engineers who are able to understand the practical limitations involved.

Part III deals with electricity supply economics. Two chapters are devoted to an excellent discussion on power factor economics and contains much useful information on the causes and effects of bad power factor together with corrective methods and their costs. Bonus, penalty and K. V. A. demand tariffs are also explained.

The three chapters on tariffs should convey a clear idea of the factors upon which tariff structures are based and of the modern methods of charging. A brief note of the comparative merits of the "step" and "block" methods of charging on a sliding scale might have been included.

The book ends with a short chapter on some general notes on power supply and a useful appendix.

Taken altogether, a very useful and informative book which can be recommended.

H. G. H.

Introduction to Electric Transients. By Edwin B. Kurtz, and George F. Corcoran, (John Wiley & Sons, Inc., New York. Chapman & Hall, Ltd., London.) 1935. Pp. 335. Price 22*s.* 6*d.*

The study of transients is one of the most fascinating in engineering and physical science, perhaps because it affords extensive applications of differential equations to physical problems, the mathematics involved being, at the same time, of a comparatively simple order, the result is that the subject is a favourite with advanced students.

The first thing one notices about the book under review is that Heaviside's Operational Methods are used in addition to or as supplementary to the conventional solutions. This is a very valuable feature indeed as it enables the student to become familiar with this very interesting and useful method of solution and also to compare this method with the conventional method of solution. At the same time the book can be read, if desired, without paying any heed to the operational solutions which are alternative.

The book is divided into two main parts, *viz.*, D. C. and A. C. transients and has an appendix on the mathematics employed in which the above is included. This is particularly convenient for electrical engineering students.

The method of treatment is what many people regard as the ideal teaching method, *i.e.*, the physical conception of each problem is stated first, this is followed by the mathematical analysis and then by the verification by the oscillograph.

It is claimed by the authors that the subject of "power transients" is given prominent place in the text as well as in a special section in Chapter X, but the examples given are on the whole very poor examples of power transients and the more important aspects of these are not touched on at all. Most of the examples given are on ordinary small laboratory apparatus.

The book, which is very well produced, affords a very interesting, easily read and instructive introduction to transient phenomena and in addition serves as a method of thoroughly learning some of the different equations which are of utmost importance to the engineer and can be strongly recommended.

K. A.

Theorie der Elektrizitat: A New Edition of M. Abraham's work. By R. Becker. Vol. I.—Einführung in die Maxwellsche Theorie der Elekrtizität mit einem einletenden abschnitte über das rechnen mit vektorgrössen in der Physik, Tenth Edition. (B. G. Teubner, Leipzig and Berlin, 1935.) Pp. 265. Price 14-50 RM; Vol. II.—Elektronentheorie, Sixth Edition. Pp. 397. Price 17 RM.

New editions of books which have become classics on the subjects concerned are welcome indeed, for such editions not only retain the spirit with which the old classics were written but also present the newer ideas, resulting from the deepening of the classical foundations. The work on Maxwell's theory of electricity by Föppl was thoroughly revised and published by M. Abraham and this work called as *Abraham-Föppl* became a classic and is well known among all the students of electro-magnetism. *Abraham-Föppl* underwent as many as seven editions in the life-time of Abraham, a fact, which bears ample testimony to the great eminence of the work. The new editions of Abraham's work by R. Becker, while maintaining all the important features of Abraham's work, also include some of the recent developments in electron theory presented by Becker himself.

In the first volume the student is introduced to the theory of vectors and vector fields. A masterly exposition of the thermodynamics of field energy is also given in this volume. The second volume begins with a chapter on the general foundations of electron theory which contains a section on the determination of the elementary charge by what is called the "Schrot effect". The chapter on the electron theory of metals contains the earlier views of Drude and Lorentz and also the newer conceptions of Sommerfeld based on the Fermi statistics. This volume also contains a fair account of both the special and the general theory of relativity and their relation with the electromagnetic field. The last chapter in the volume is on the theory of radiation based on the quantum of action.

Becker's edition was published before the announcement of Born-Infield's work on electrodynamics. We venture to suggest that the inclusion of an account of this theory in a later edition would be most desirable.

No effort has been spared by the Editor to make his editions useful to the teachers and students alike. The number of diagrams has been increased many-fold and this will assist the students in obtaining a vivid comprehension of the text. A section on problems of great physical interest has been included and their solutions also suggested.

Becker should be congratulated for bringing out these new editions of Abraham's work which will undoubtedly prove invaluable to students and teachers. We have no hesitation in recommending these two volumes to all those interested in electro-magnetism.

N. S. N.

Fluorescence Analysis in Ultra-Violet Light. By J. A. Radley, B.Sc., A.I.C. and J. Grant, Ph.D., F.I.C. (Chapman & Hall: London.) 1935. Second Edition., Pp. 326. Price 21 shillings.

The book is one of the series of monographs on applied chemistry edited by Dr. E. H. Tripp. It contains two parts; the first part deals with the theory and technique of fluorescence analysis. Here, the authors discuss briefly the production of ultraviolet light and the method of analysing fluorescence both qualitatively and quantitatively. The various types of lamps and filters that are now in use are discussed and their advantages and disadvantages are pointed out. The authors are of opinion that "the varying results sometimes obtained by different workers for the same substance are often due to lack of precision in defining the technique". Research workers in this line will be in entire agreement with the authors of this book, for the importance of the method that is employed for the analysis and the pitfalls that are to be taken care of are well known. On the whole, this part of the book has been very well written and will serve as a useful guide to those workers who are interested in this subject.

In the second part, the authors give a large number of instances in which fluorescence analysis has been used for both pure and applied science subjects. Here, they had a difficult task to perform, for more than 800 papers had to be summarised. The result has been that information given in some cases is rather scanty. The research workers, however, will find a full list of references at the end of each chapter dealing with different subjects. Finally it may be said that, as far as we know, this is the only book in English language on the

subject of fluorescence analysis and that the appearance of its second edition within such a short time shows how much it has been in demand.

K. A. C.

Wireless—Its Principles and Practice. By R. W. Hutchinson; third edition, xii + 316 pages with 224 figures. Published by the University Tutorial Press. Price 3*s.* 6*d.*

This book obviously meets a real need: or it would not have gone through three editions and some ten impressions between December 1932 and November 1935.

It is expressly meant for the growing army of those who are interested in radio but whose knowledge of mathematics and physics is strictly limited.

In simple and straightforward language, the author deals with the elements of electrical theory and continuous and alternating current circuits, some of the methods of generating electromagnetic waves and the phenomena of wave travel in the earth's atmosphere. More than half of the book is devoted to the numerous types of thermionic vacuum tubes and the different circuits of a modern radio receiver in which they are used. The examples are of tubes of British make. There are also short descriptions of the chief features of the battery, all-mains and superheterodyne types of receivers and of small transmitters. The last chapter deals with the elements of television and of the cathode ray oscillograph.

It will be gathered from the above that the author has endeavoured to make the book up-to-date. The language is everywhere lucid and brief, and suitable for the class of readers for whom it is meant. The numerous excellent illustrations are very helpful.

The price is quite moderate and the book can be recommended in every way to the beginner and the amateur of radio.

R E

A Class Book of Magnetism and Electricity By H. E. Hadley. (Macmillan & Co., London, 1936.) Pp. x+512. Price 6*s.* 6*d.*

The author of this book needs no introduction to the students of secondary schools as they are all familiar with his text-books. The present publication intended for students of the Intermediate College comprises a somewhat advanced treatment of Magnetism and Electricity.

The volume begins with a chapter on the fundamental properties of the electric current and is followed by a chapter on some of the practical aspects of magnetism with which every reader ought to be familiar. In these two chapters the author gives the students a rough outline of the subject and introduces him into the various topics, which are more elaborately dealt with later. Theoretical considerations of the various properties of the electric current and magnetic fields are introduced and are amply supported by numerous numerical examples, which enable the student to acquire a thorough and comprehensive knowledge of the subject-matter. The addition of "Historical Notes" at the end of each chapter, will further give the student a chronological account of the theories and principles described; starting from the earliest conceptions of the ancient scientists, the author has chronicled the achievements of the scientists of the succeeding ages. A few chapters towards the end deal with many of the modern practical applications of magnetism and electricity, such as radio-activity, broadcasting, talky-films, television, etc., which have proved so inscrutable to the lay reader.

The book is invaluable not only as a class book to those students preparing for the Intermediate Examination, but also to every literate reader who is desirous of getting an easy and eminently readable introduction to the study of a branch of physics of wide interest on account of its extensive and rapidly increasing practical applications.

The treatment is elegant, simple and always to the point. The book is copiously illustrated and the addition of answers to numerical questions and an index, enhance the interest and usefulness of the publication. The get-up and printing of the book are of the traditional excellence of Messrs. Macmillan & Co.

H. L. N.

Indian Zoological Memoirs. V. Herdmania. By S. M. Das, D.Sc. (Lucknow Publishing House, Lucknow, 1936.) Pp. x + 103. Price Rs. 2.

The fifth of the series of the memoirs on Indian Zoological types deals with an account of the common Monascidian of the Indian seas, *Herdmania pallida*. The introduction includes the classification of Tunicata (after Garstang) which should prove useful to all students of the group. An account of the Bionomics and distribution of the genus is given which shows that it enjoys almost universal distribution and is represented in

the Indian seas by *H. pallida* and *H. ceylonica*. Of these, the former is the more common and the memoir deals with all the systems of organs in great detail. The figures are all original and amply illustrate the descriptions in the text. The high standard set by the earlier memoirs of the series is maintained by the book and it will doubtless be a valuable guide to students in many colleges in India, as well as a reference volume of considerable importance to workers all over the world.

Library Administration. By S. R. Ranganathan. (Published by the Madras Library Association.) Price 12/6.

The author himself says in the Introduction, "This is not a book to be read through like the *Five Laws of Library Science*. It is on the contrary a most prosaic manual full of details." The claim that is made for the book is that it is a reference work capable of guiding the Library Staff to discharge their duties "with highest possible accuracy, greatest promptness and economy". The author says that this should not be treated as a manual to fit every kind of library, but only as giving certain "patterns that can be varied according to local conditions".

Any administrative manual must have as its ultimate end the inculcation of fundamental and basic principles that govern the administration of the particular office, and rules and regulations must be so devised as to keep afresh these general principles in the minds of the staff responsible for the working of it. The accuracy and promptness in the observance of such rules will ultimately tell on the quality of service and the reputation of the office. Doubleday, in his *Manual of Library Routine*, says: "Working methods have to be carefully studied; their details have to be carefully comprehended, rules and regulations should be learnt and the allotted duties should be discharged with goodwill, interest and zeal. This and this alone is the royal road to success."

If the general principles are to be thoroughly grasped by the Staff, it is absolutely necessary that they must be of a fundamental nature, and as brief as possible. An undue elaboration of mechanical rules and devices for working methods, may foster in the minds of the Staff a love of red tape and fascination for administrative routine, and blind them to the real responsibilities of their position.

The chief defect of the book under review is that the rules for any section are too many, too minute and detailed and the whole book is 'over-weighted with details' (to use the language of the Introduction)—'details' which a Library Assistant, who is newly posted, can hardly be expected to master. It is a hard task even for Librarians to wade through the numerous chapters, covered with too many details and unnecessary amplifications of rules of working methods. One would wish that the author had left some of the minor points to the intelligence and resourcefulness of persons concerned in the several departments.

Obviously, the book, dealing with an infinite number of rules and regulations, is useful only for Libraries having at least a few dozens of members to man their staff, and several heads of sections to supervise their work. It can have no application to Libraries having a small staff and fewer number of books, like the School and College Libraries in India. Probably, the administrative machinery evolved may be found quite suitable and appropriate to the Libraries of the type of the British Museum and the Bodleian.

The book contains three parts. The first part is entitled the 'Groundwork'; the second is called 'Distinctive Library Functions'; and the third is named 'General Office Functions'.

The first part describes the general principles of administration and is simple in treatment. In the second part, there are eight different chapters covering subjects like 'Book Selection', 'Book Order', 'Periodical Publication', 'Accession Section', 'Technical Section', 'Counter Section', 'Reference Section' and 'Shelf Section'. The third part deals with twelve different topics, *viz.*,—'Committees', 'Staff Section', 'Staff Council', 'Over-seeing', 'Publicity Section', 'Finance', 'Accounts', 'Records', 'Correspondence', 'Printing', 'Binding', and 'Stores' and a chapter is devoted to each of these.

Each of these chapters contains the following headings—Planning, Job Analysis, Routine, Oversight, Correlation, Time Scheme, Forms and Registers—the same subjects are discussed again and again in different view points with minuteness and detail.

In the chapter on Book Order, a few suggestions regarding the sources for finding the addresses of the numerous Publishers would doubtless have enhanced the value

of the publication. In the Periodicals Section, the three-card system is advocated, which may be resorted to when the periodical publications range over a thousand, and this can have no application to smaller libraries. The author's advice to deal directly with the Publishers of periodicals is a wholesome advice to all Librarians. The work of entrusting them to an agent, with a view to effect a small saving, would result in irregularities in service and land the authorities in financial loss. The author feels, correctly that, in the revision of periodical publications, the Committee should treat the Librarian's views with consideration.

Instead of leaving the acceptance of all gift books to the individual discretion of the Librarian, it would have been better if a few rules had been framed for accepting them. The idea of an Indemnity bond mentioned in the chapter on Counter Section for lost tickets may not be agreeable to all Librarians. While it may check all unauthorized borrowings on lost tickets, the rule will work as a hardship on innocent users of the Library who might happen to lose their tickets by accident.

The chapter on Reference Work is well planned and written. It can have no application to School and College Libraries in India.

One would wish that the author had given suggestions for proof correcting in the chapter dealing with Printing, in Part III. The chapter on Binding is fairly exhaustive and sufficiently adequate.

All the subjects of day-to-day administration are very minutely and patiently described with great care and accuracy. One would only wish that the numerous details had been omitted and the book had been made readable and attractive like all other books on the same topic. There is no rule to the effect that books on Library Administration should not be read through and afford real pleasure in the grasp of the fundamentals of administration.

K. N.

Forest Research in India, 1934-35. Part I. The Forest Research Institute. (Manager of Publications, Delhi, 1935.) Pp. 89. Price Re. 1–8–0 or 2*s.* 6*d.*

This official publication summarises the work done during the year 1934–35 at the Forest Research Institute, Dehra Dun. A general review is followed by five chapters, each dealing in turn with the Silvicultural, Botanical, Entomological, Economic and Chemical Sections of the Research Institute.

Within the limits of so concise a publication, one could scarcely expect little more than a mere cataloguing of the different problems tackled. To the student who is specially interested in any of these, there are the Institute publications, a useful list of which is given as Appendix II at the end of the volume.

The admirable range, quality and quantity of the work turned out by the Dehra Dun Institute is at once an eloquent plea and a justification for the multiplication of such institutions in India. Many Forestry problems, while important, have no more than local significance, and even otherwise, a first-hand knowledge of local conditions is a *sine qua non* in this type of research. And in a country of continental dimensions like India—encompassing as it does many climes and types of forests—this need is all the greater. And a single Forest Research Institute like the Dehra Dun Institution is like a "light which makes the darkness visible". The ideal would be a central co-ordinating agency with different regional investigation centres on the model of the Imperial Institute of Agricultural Research. May the Dehra Dun Institute with its fine traditions and record of achievements prove to be such a co-ordinating agency!

The book is printed (as can be seen from the water-mark) on paper manufactured at the experimental plant of the Institute. It is curious that this fact finds no mention in the book itself.

EMMENNAR.

Sulphitation of Lac. By R. Bhattacharya and Lal C. Verman. Technical Paper No. 6. London Shellac Research Bureau, London. Jan. 1936. Pp. 20.

That lac can be dispersed in aqueous solutions of sulphurous acid or alkali sulphites and bisulphites is the latest discovery of the Indian workers on lac stationed at Teddington. The stability of the solution is secured by the addition of anti-oxidants like glycerol and ethanolamine which inhibit the oxidation of sulphurous acid. The possible chemical reaction between the lac and sulphurous acid is stated to be mainly the addition of sulphurous acid or bisulphite to oxygen atoms which exist between pairs of carbon atoms, with the formation of oxonium compounds.

The sulphited lac resin has a higher iodine value and there is also a definite increase in its saponification value. From the practical point of view the coatings of sulphited lac on baking, yield films which possess greater adhesion, flexibility and hardness while even air-dry films resist dilute alkalies, acids and ordinary solvents.

Shellac is used considerably as a thermoplastic binder in plastic moulding; the incorporation of fillers by the "dry" hot process consumes considerable power in grinding and mixing operations and the employment of alcohol for this purpose is expensive. It is suggested that the aqueous dispersions of lac in sulphurous acid offer a suitable and inexpensive medium in which fillers and fibres can be intimately incorporated. The sulphited lac is coagulated or caused to precipitate on to the filler, thus ensuring an extremely uniform distribution of the binding material. It should, however, be added in this connection that this principle has long been adopted in the course of the work carried out at the Indian Institute of Science, employing aqueous dispersions of lac in sodium carbonate which are often bleached with hypochlorite, when a pigmentation of the moulding powder is desired.

But the great merit of sulphited lac from the point of view of moulding appears to be the fact that the product is brought to an advanced stage of polymerisation: and its softening point is raised to about 130° C. The time of "after curing" is therefore shortened and the additions of accelerators are found to be unnecessary.

M. S.

Errata.

(1) Vol. IV, No. 9, p. 650, under the rational constitution of formic acid,

Read

$$\begin{tikzcd}[column sep=small] \mathrm{H^+} & \mathrm{C} \arrow[l] & = \mathrm{O} \\ & \mathrm{OH^-} \arrow[u] & \end{tikzcd}$$

Ray and Sarkar

for

$$\begin{tikzcd}[column sep=small] \mathrm{H^+} & \mathrm{C} \arrow[l] & = \mathrm{O} \\ & & \mathrm{OH^-} \arrow[u] \end{tikzcd}$$

Ray and Sarkar

(2) On page 767, under 'Recent Advances in Sanitary Science,' line 1 (first column) should read thus: "The following is the *abstract* of an address......".

397-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.

Current Science

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CONTENTS.

The Indian Lac Industry.

THE Indian Lac Industry is one of the few indigenous monopolies of India, which has been struggling to maintain its position under the competitive pressure of synthetic substitutes. Its continued preservation and prosperity are of paramount importance to India, since the industry supports a large population of poor and humble peasants who are enabled to supplement their meagre income by the cultivation of lac. The industry has passed through many vicissitudes; in 1878 its export value dwindled to 2 lakhs, and in 1883 the trade had practically ceased. When, however, the importance of the resinous ingredient of lac came to be recognised, there was a steady increase in the exports which reached a value of 32 lakhs in 1888, and in 1908 the value rose up to two crores and a half.

During the Great War, the heavy demand made upon this material was responsible for the unprecedented inflation of prices which touched 880 shilling per cwt. in January 1920, a price which exposed the trade to the imminent danger of stimulating the production of substitutes. The industry had suffered greatly in reputation on account of the violent fluctuations in price and uncertainty of supplies due to the frequent failures of crops and to the unrestricted and unscrupulous adulteration of the product. The Government of India, realising the seriousness of the situation, appointed a Committee to investigate the various technical and commercial aspects of the industry, which resulted in the publication of the Lindsay and Harlow Report in 1921. Acting upon the recommendations of the Committee, an Indian Lac Association for Research was formed, the Research Institute at Ranchi founded, and a lac cess levied, with the main object of promoting improvements "in the breeding of lac and its manufacture through scientific methods or by such means as shall be decided upon by the Association".

The control of the funds and the management of the Research Institute were vested in a Committee of the Association and not in any statutory authority. Three representatives of the Calcutta shippers, two of the Indian manufacturers, two of the Indian

brokers, one of the European manufacturers and one of the European brokers constituted the Committee which continued to guide the destinies of the industry and control and direct the Research Institute at Ranchi till 1930.

The progress achieved during this period was necessarily slow since the Committee was not fully alive to the immediate necessities of the industry. At a meeting of the Association held in May 1929, one of the important members complained that "no results of any importance to the trade had yet emanated from the Institute which had been in existence for about eight years". He characterised as wasteful the large expenditure incurred by the trade and by the cultivator in particular on the Institute's behalf, and he suggested that the Association should be wound up or handed over to Government. This was of course an extreme view, but it was clearly indicative of the fact, that the trade was not particularly interested in the work carried out at the Institute.

The valuable experience gained during this period of ten years, brought a new outlook on the industry. At the commencement the research activity was mainly directed to the investigation of the methods of propagation to secure steady and enhanced yields of lac, but it was soon discovered that work on the manufacture of lac with an appreciation of the consumers' point of view was of greater urgency and importance to the industry. The Committee, accordingly, appointed a physico-chemist and extended the scope of the Institute by establishing a separate department for investigating the manufacturing methods and for determining how the manufacturer may best meet the needs of the consuming trade abroad.

With a view to maintain a close *liaison* between the consuming industries in Europe and America and the Research Institute at Ranchi, Mr. Marshall, President of the Association, suggested the appointment of a Lac Marketing Expert in London, who would keep the Association advised in regard to the requirements of manufacture in England, and undertake on behalf of the Association, the testing out of the various standards of lac shipped from India. Mr. A. J. Gibson, who was accordingly appointed Special Officer, Lac Enquiry, in 1929 has rendered great service to the Indian Lac Industry, by establishing useful and intimate contacts with the consuming industries in Europe, and securing their co-operation in organising applied research with the assistance of the London Shellac Research Bureau.

The Committee of the Indian Lac Association, in spite of its many failings and the slow progress, prepared the ground for the next phase in the organisation of the industry. In 1929, the Committee addressed a Communication to the Government of India, with regard to future of the Association, and felt in an ever-increasing measure that they were not in a position to control effectually and to the best advantage, the future conduct of research in the Lac Industry, having neither the necessary knowledge nor the necessary experience. In particular, the Committee recognised its inability to bring home to the cultivator the results of the research work at the Institute. The Association with the concurrence of the Government of Bihar and Orissa accordingly recommended that the Lac Cess Act should be replaced by a fresh measure providing for the continuance of the lac cess and constituting a statutory committee on the lines of the Central Cotton Committee, which should take over the control of the Research Institute and administer generally the lac cess funds.

The termination of the Indian Lac Cess Act of 1921 by the end of 1931, was taken advantage of not only for reorganising the administrative committee, but also for giving effect to the recommendations of the Royal Commission of Agriculture, who emphasised the importance of bringing together the various interests in the industry, somewhat on the lines of the Indian Central Cotton Committee and of including in the body entrusted with the control of the lac cess funds, nominees of the Government of India and of the Government of Bihar and Orissa, and an official to represent the interests of cultivators. They wrote "From our point of view the chief interests are that of the cultivator, and, in consideration of the value of the industry, its importance in providing subsidiary employment throughout such a large area and the pressing need for measures to save it from destruction by the synthetic article, we are of opinion that the Association should be reconstituted and strengthened by the addition of nominees of the Government of India and of the Government of Bihar and Orissa, and of an official to represent the interests of the cultivators. The Imperial Entomologist and

the Chief Conservator of Forests of Bihar and Orissa would be suitable nominees for the first two posts. It is doubtful if any satisfactory representative of the growers could be found, and we accordingly recommend that the Chairman of the Association should be the Commissioner of Chota Nagpur. The Institute is situated in his division and it would be his particular responsibility to bring to the notice of the Association the best methods of promoting the interests of the growers. He would also attempt to keep in view the wishes of other provinces where lac-growing is important and to protect the staff of the Institute from difficulties arising from the fact that most of the members of the Association reside some distance away in Calcutta."

"We also recommend that inquiry should be made, under the general supervision of the Chairman, into the economics of lac-growing."

The Government of India utilised this opportunity to enlarge the definition of the objects to which the proceeds of the lac cess might be applied, so as to include within its scope the investigation of marketing methods and the promotion of sales. The Indian Lac Cess Act of 1930, provided for the constitution of an "Indian Lac Cess Committee" which was more representative in character and which was empowered to undertake the improvement and development of methods of cultivation, manufacture and marketing of Indian lac. As Chairman of the Statutory Committee, the Government of India suggested the appointment of the Vice-Chairman of the Imperial Council of Agricultural Research, who as Chairman of the Indian Central Cotton Committee and of the Sugar Committee, would bring valuable experience to the work.

The inauguration of the Indian Lac Cess Committee under the energetic chairmanship of Sir T. Vijayaraghavacharya marks the beginning of the second phase in the development of Indian Lac Industry. This period has been eventful in many ways; research was extended to the manufacturing and technical aspects of the industry, with a view to produce natural lac in forms and modifications best adapted to meet the requirements of the consuming industries. This involved a more intimate touch and a closer co-operation with the manufacturing concerns, interested in the exploitation of this raw material, and led to the policy of conducting research at the consumers' door. In pursuance of this policy, two Indian chemists and one Indian physicist have been stationed in England to conduct research in the laboratories of the great consuming research organisations.

The three principal lac-consuming industries are the electrical, the plastic and the paint and varnish trades, and the Indian Lac Cess Committee have been fortunate in securing the co-operation of some of the foremost research organisations in England. The High Commissioner for India is officially supervising the work of the Indian scientists, and is assisted by a strong Advisory Committee in London on which the experts and the trade and manufacturing interests are represented. This new and progressive policy sponsored by Sir T. Vijayaraghavacharya and his Committee, has already borne some fruit, and promises to yield a richer harvest. In the words of the High Commissioner for India "Given the necessary concentration of effort, close consultation and co-operation of producers, distributors, consumers and research workers, adequate co-ordination of results and the confidence of all concerned, the prospects of further success and the ultimate granting of a new lease of life to the old-established Indian Lac Industry are definitely bright."

The Indian Lac Cess (Amendment) Act of 1936, which has just been promulgated, may be said to place the Indian Lac Industry in its third phase of development. The Act provides for the constitution of the Indian Lac Cess Committee which consists of a Governing Body entrusted with the management of the affairs and the administration of the funds of the Committee, and an Advisory Board to whom all matters of a technical or scientific nature proposed for consideration by the Committee should be referred. There is a very generous representation of all interests on these two bodies, and, if the powers are properly exercised, there should be no room for complaint from any quarter. Provision has been made for the representation of lac-consuming industries and also for "two scientists to be nominated by the Governor-General in Council" and this constitutes a welcome and refreshing feature of the New Act. The scope of the Committee has been further extended so as to enable them to utilise the funds in "meeting

expenditure hereto and hereafter incurred in securing patents for the protection of inventions by employees of the Committee." The Act also provides "for the periodical inspection by persons appointed in this behalf by the Governor-General in Council of the Indian Lac Research Institute and other institutions maintained by the Committee".

The Act empowers the levy of an enhanced cess on lac and lac refuse; seven annas instead of four annas on lac and five annas instead of two annas on lac refuse. This would result in a substantial increase in the revenues of the Committee, which should take advantage of the increased prosperity of its finance in continuing and consolidating the progressive and fruitful policy laid down by the previous administration.

For sometime past there has been a just cause for complaint that the funds of the Indian Lac Cess Committee have not been made available for encouraging research and conducting propaganda in America, which is entitled to special consideration in view of the fact that she consumes more than fifty-five per cent. of the total production of lac. The phenomenal development of synthetic rivals in America during the last decade has been so great that, but for the simultaneous development of the lac-consuming industries, shellac would have lost much ground in that country. A lac marketing expert and a research organisation much on the same lines as the one stationed at Teddington, should be maintained in America to understand and investigate the special requirements of the American consuming industries. Such an arrangement which is long overdue would stimulate the consumption of lac in America and bring increased prosperity to the Indian Lac Industry.

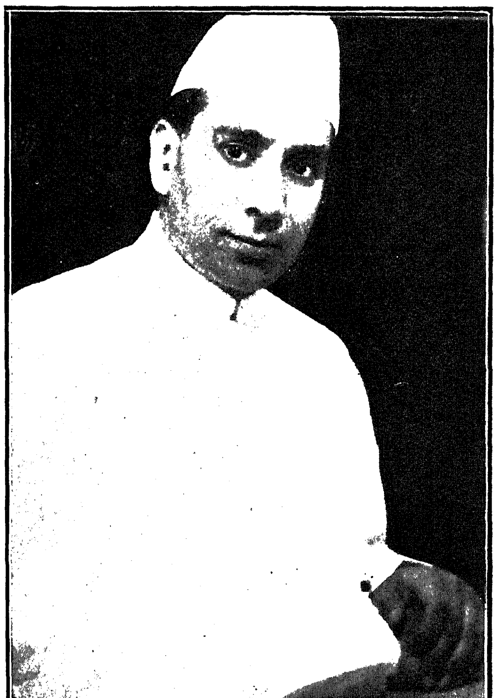
Under the present circumstances the policy of conducting research at the "consumers' door" is the only course that can effectively advance the interests of the industry, but the time has arrived when the Committee should adopt a vigorous policy of encouraging the development of lac-consuming industries in this country. When Japan's Camphor Industry was threatened with severe competition from synthetic camphor from Germany, and when she could no longer maintain an economic price for her natural product, Japan founded the celluloid industry which consumes a considerable portion of this raw material. This would entail a well-planned programme of pure and applied research in collaboration with various research centres and industrial organisations in the country who are interested in the utilisation of lac. The Committee should take advantage of the facilities offered by the two great research centres in India, Bangalore and Calcutta, and harness their resources in the service of the industry. The Indian Institute of Science at Bangalore, where Dr. Gilbert J. Fowler originally organised researches on lac, has done considerable work; and the Departments of Physics and Electrical Technology which have an exceptionally up-to-date equipment could profitably be utilised in promoting further advancement in this connection. One way in which such a collaboration can effectively be secured is to nominate the two scientists, one from Bangalore and the other from Calcutta, to the Advisory Committee. If the New Act could lead the Indian Lac Industry to greater prosperity and increased stability, the enhancement of cess would have more than justified itself. The working of the New Act would be watched with the keenest interest by every one interested in the advancement of this time-honoured industry.

M. S.

Professor Birbal Sahni, D.Sc., Sc.D., F.G.S., F.A.S.B., F.R.S.

THE news that Professor Birbal Sahni has been elected a Fellow of the Royal Society will give the greatest satisfaction among his numerous colleagues, friends and students. On behalf of our readers we have great pleasure in offering him the warmest congratulations of *Current Science*.

Professor Sahni comes of a gifted family belonging to Bhera, Punjab. He is the third son of Mr. Ruchi Ram Sahni, Retired Professor of Chemistry, and the late Shrimati Ishwar Devi (*née* Anand); the former, a pioneer educationist of the Punjab, is distinguished for his activities leading to the advancement of scientific prestige in India and the latter was well known for her piety and culture.



Prof. Birbal Sahni, D.Sc., Sc.D., F.G.S., F.A.S.B., F.R.S.

The influence of his father during his tender years and later that of Professor A. C. Seward at Cambridge inspired Professor Birbal Sahni's whole subsequent career of scientific research. At the University of Cambridge which he entered in October 1911, he became a Foundation Scholar and later a life-member of Emmanuel College. Both in Cambridge and London, he distinguished himself by his original researches which brought him the doctorate degrees of the two Universities.

In India honours have come to him thick and fast. He is Professor and Head of the Department of Botany in the University of Lucknow, Dean of the Faculty of Science, Lucknow University; one of the Founders and an ex-President of the Indian Botanical Society; ex-President of the Lahore Philosophical Society; President of the section of Botany (1921) and of Geology (1926) of the Indian Science Congress; Fellow of the Asiatic Society of Bengal; one of the Vice-Presidents of the Indian Academy of Sciences and of the National Institute of Sciences; a former Vice-President and now Foreign Secretary of the National Academy of Sciences (U. P.); recipient of the Barclay Medal of the Asiatic Society of Bengal for his researches in biological science (1936). He was one of the Vice-Presidents of the Palæobotany Section at the 5th International Botanical Congress, Cambridge, 1930, and again at the 6th Congress, Amsterdam, 1935.

His published original papers cover a wide range of subjects in botany, but his interest has lain chiefly in the study of extinct plants, which has led him into the domain of geology. His scientific achievements, which deal largely with the flora (present and past) of India and of the Southern Hemisphere, are marked by a broad philosophical outlook and intensive field researches. He is the leader of a small but enthusiastic school of young botanists, whose activities are recorded in the Quinquennial Reports of Research published by the University of Lucknow.

The election into the Royal Society has come to him at a comparatively early age, and *Current Science*, which owes a great deal to Professor Birbal Sahni, confidently hopes that his further scientific work will bring him higher distinctions, and the country, he loves, greater glory.

Antiquities from the Khokra Kot Mound at Rohtak in the Jumna Valley.

By B. Sahni, SC.D., F.A.S.B., F.R.S.
Professor of Botany, Lucknow.

DURING a flying visit to Rohtak[1] (Long. 76° 35′ E., Lat. 28° 54′ N.) on March 24, 1936, my attention was drawn by a friend (Dr. V. S. Puri, Ph.D.) to certain mounds at Khokra Kot in the immediate outskirts of the city. The mounds cover an extensive area and rise, at a rough guess, 20 to 30 ft. above the surrounding country. In places their structure is exposed in the steep sides of ravines cut by the rains. Here even a casual observer would not fail to notice the great profusion of old bricks, bits of pottery, bones and other relics exposed at different levels in the crumbling sides of the ravines. In one of these ravines, during the two half-hours available to me, a varied collection was made of which a full description will be published elsewhere. Meanwhile a few remarks may be offered on some of the more interesting finds.[2]

(*a*) *A mint of the Yaudheyas* (*ca.* 100 *B.C.*).—In a well-defined dark layer only a few inches thick and a couple of feet in horizontal extent, exposed in the side of a cliff at about three feet below the surface. I collected, *literally in hundreds* during the course of a few minutes, fragments of black terra cotta discs like those shown in the reconstruction in Fig. 1. The discs were perforated in the centre and were marked on both faces with a depressed wheel-like pattern, the eight spokes of the wheel ending in as many circular seal-like impressions (also in negative relief). As Rai Bahadur Pandit Prayag Dayal, Curator of the Central Museum, Lucknow, to whom I showed the relics, at once remarked, these discs are no doubt matrices or moulds in which coins must have been cast in molten metal. Some of these moulds were found sticking together in piles of two or more. The abundance of material in hand, and the excellent state of its preservation enable one to form a very adequate idea of the technique employed. We obviously have here a dump of discarded moulds from an ancient mint. While reserving the details for the full paper the mode of casting may be indicated here in a diagram (see Fig. 2). The metal (shown dotted) was poured in through the vertical canal in the centre, and must have spread radially into the coin sockets at different levels in the matrix. An interesting point is the oblique line seen on the rims of many of the fragments. This must have served as a key to enable the discs to be replaced accurately in position (Fig. 2 *a*).

Since writing the above I have actually found, on splitting some of these fragments apart, virgin coins still embedded in their sockets, from which they first saw the light 2,000 years after they had cooled in the matrix. The metal used for these coins was bronze, not copper. A fragment kindly analysed by my colleague Dr. A. C. Chatterji showed a small proportion of tin and also a little iron. The Latin word *aes* (*Æ*) as generally used by numismatists is perhaps a legacy from the early days when copper, bronze and brass were confused under the one name. These coins contain no zinc.

About the signs and script on the two faces of the discs I dare not at present say much. The obverse shows a humped bull (*Bos indicus*), always facing right and with the head turned obliquely towards the onlooker (Fig. 3); in front of it there is always the conventional sign of a tree within a railing, and round the margin a well-preserved legend in the Brāhmī script. This legend, hitherto incompletely read on similar coins figured by Cunningham,[3] Mr. K. P. Jayaswal has kindly interpreted for me as follows: *Yaudheyānā* (*m*) *Bahudhāñake*. The proper name *Bahudhāñake*, according to him, denotes either the place where the mint was situated or (more probably) a political community included in a federal league of the Yaudheyas, a famous warrior tribe whose sway extended over a large part of the southern and south-eastern Punjab.[4] If the latter interpretation is correct the legend would mean "amongst the Yaudheyas the Bahudhāñakas".

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[1] In response to an invitation from the Punjab University to deliver extension lectures in Botany. Rohtak lies about 40 miles west-north-west of Delhi, about 250 miles in a bee-line from Harappa and 560 from Mohenjo-Daro.

[2] These relics were exhibited at a public lecture in Rohtak (March 24) and again at a lecture delivered before the Philosophical Society, Patna (April 14).

[3] *Coins of Anc. India*, 1891, pl. VI, 2, 3.

[4] Cunningham, *Coins of Anc. India*, 1891, pp. 75-79; Rapson, *Ind Coins*, 1898, pp. 14-15.

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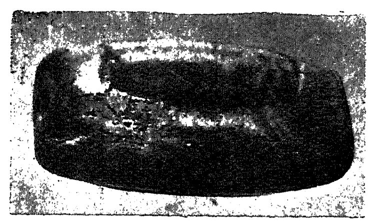
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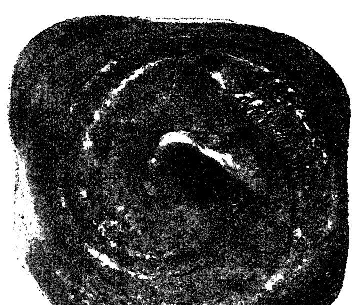
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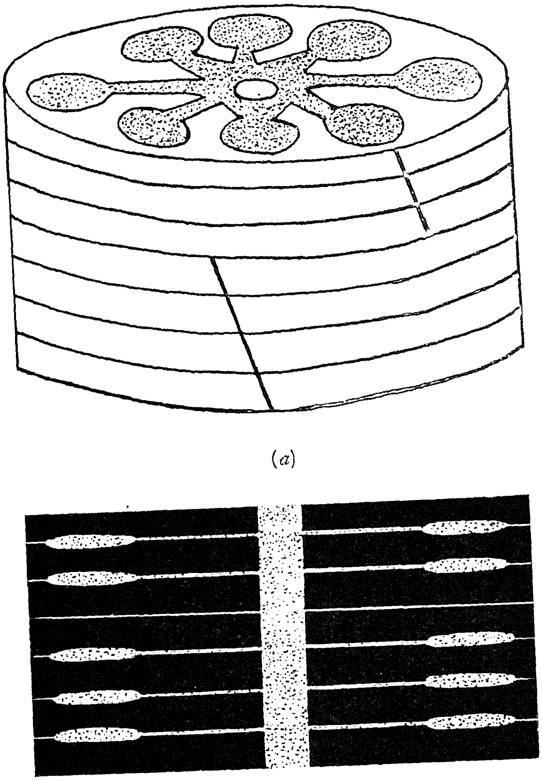
Figs. 1, 4, 6, 7, 9 are natural size; fig. 5, × 2; fig. 8, *ca.* × 4½; fig. 10, × 2.



(a)

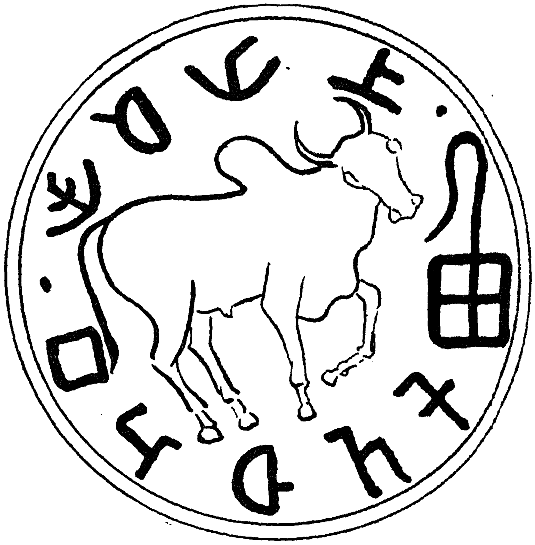
(b)

Fig. 2.

The reverse bears the Indian elephant (*Elephas maximus*), also (almost) invariably facing right, in various standing or running postures, but always with the trunk up-raised. Above the elephant's back there is constantly the Brāhmī letter *ga* (like an inverted V or Y), accompanied by the *triratna* or *nandipada* symbol (Fig. 5).

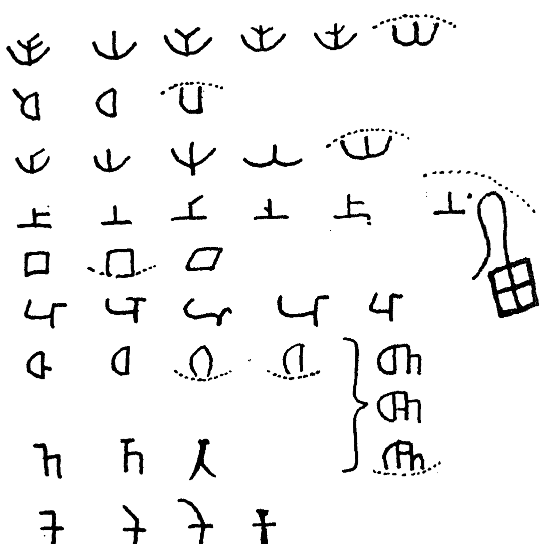
After Mr. Jayaswal's independent reading of the legend on the matrices I was able to confirm it with the help of Bühler's palæographic charts.[5] In Fig. 3*b* I have recorded all the variations in the characters that I was able to find amongst the several hundred fragments collected. In Fig. 3*a* is given the full version of Mr. Jayaswal which, it must be stated, was made up from a number of fragments not belonging to the same impression.

There can be no doubt, as Mr. Jayaswal suggests, that the coins made from these moulds belonged to the Yaudheyas; the identical coin has been figured by Cunningham who gives the age as *ca.* 100 B.C. Cunningham mentions on the reverse a combined *triratna* and *dharma-chakra* symbol but his figures do not show a *chakra*, nor do I find a sign of it on any of my numerous well-preserved moulds.



(·)
यौधेयानां बहुधाञके।

(a)



(b)

Fig. 3.

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[5] *Grundriss*, 1896, Taf. II, IIa.

Apart from making it possible to decipher the complete legend and providing a large number of variations in the alphabet, as well as in the details on the reverse, the discovery of the actual apparatus in which these coins were cast affords valuable data concerning the technique of coining in India in pre-Christian times.

There is one more point to which I may be allowed to draw attention. Before I knew anything of the age of these coin-moulds — indeed before I realised that they were coin-moulds at all — I was struck by the resemblance of certain features with the seals from Harappa and Mohenjo-Daro. The humped bull and the elephant were common to the two; they also almost invariably faced right; then there was the enigmatical square divided into four, also commonly found in the Indus script. Later I learned that this was the conventional sign of a railing round a tree: and a tree before a bull was also to be found among the Indus seals. Lastly, there was the curious fact that my elephants frequently had a clearly bifurcated tail (see Fig. 4): this feature was looked for amongst the Indus seals and there it was again.[6]

I mention these facts because several others have independently noticed resemblances between Indian punch-marks and certain signs on the Indus seals which they have (probably rightly) regarded as their prototypes. Dr. Pran Nath drew attention to these resemblances in 1932,[7] Mr. Durga Prasad in 1933,[8] and Dr. Fábri in 1934.[9] The present instance shows that some of the ancient features were carried on to the *cast* coins as well, at least down to the 1st century B.C.

I must also confess that in my complete ignorance of Brāhmī it was to the Indus script that I naturally turned for possible clues to affinity, and I imagined that I saw several points of resemblance, even of identity. I was thus led to suspect that the two scripts were probably related. Subsequently I learned that more than one noted palæographer holds the view that Brāhmī was derived from the Indus script; so I took the first opportunity (April 10) of discussing my material at Benares with Dr. Pran Nath, to whom I am much indebted. To a complete novice in palæography the possibilities of reading an unknown script in various directions, and at all sorts of angles, could only be a source of bewilderment. However, I came away convinced that my script had *some* relation with the Indus writing, although I must say I was not really satisfied till Mr. Jayaswal, happening to visit Lucknow on April 30, led me by the hand through the wonderful labyrinths of Brāhmī, and fixed the age of the coins beyond doubt.

The dark band exposed in the cliff at Khokra Kot thus certainly represents the site of an ancient mint of the Yaudheyas; and Rohtak not only lay within the area of circulation but was actually one of the distributing centres of their coinage. I have no doubt that further discoveries of importance may be expected from a systematic excavation of the site.

(*b*) *Paddy husk and charred grains of wheat or barley.*—It seems that either the matrices just described were baked over a slow fire of paddy and wheat or barley, or that they were packed in these cereals while the molten metal was poured into them. Well-preserved impressions of paddy husk, as well as entire though charred grains of a cereal (which can only be wheat or barley) have been found sticking to the rims of some discs and to the bottoms of the basal discs of a pile, in the form of a more or less thick carbonised crust. Recognizable impressions of paddy, clearly showing the cell structure of the paleæ, have also been found in the substance or on the surface of many pieces of brown pottery. Husk appears sometimes to have been rather freely mixed with the potter's clay.

(*c*) *The black terra cotta model of a humped bull* (Fig. 6) was found loose, below the cliff in which the clay matrices were found, and was probably derived from the same layer.

Apart from the above I have a few relics of rather uncertain age, some of which were found *in situ*, not far from the cliff containing the coin matrices, but from a level distinctly lower than the latter. I am inclined to regard these as much older, possibly representing the prehistoric (Chalcolithic) civilisation which was first recognised in India by the late Mr. R. D. Banerji at Mohenjo-Daro and by Rai Bahadur Daya Ram Sahni at Harappa. Further enquiry is needed to prove their antiquity, but

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[6] Marshall, *Mohenjo-Daro,* 1931, pl. CXII, 364, 366; pl. CXV, 534.

[7] *Ind. Hist. Quart.*, 1932, VII, 11 ff.

[8] *Journ. Proc. As. Soc. Beng.*, 1933, XXX, *Numismatic Suppl.* for 1934.

[9] *Journ. Roy. As. Soc.* for 1935, 307–318; see Jayaswal, *Ibid.*, 720–721.

they certainly justify the suggestion that the site should be explored in its deeper strata.

(*d*) *The glazed pot of white paste*, bearing on its inside a very clear impression of finely woven cloth (Figs. 7, 8) at once recalls Mackay's account of similar relics found at Mohenjo-Daro.[10] This interesting specimen was pulled out of the exposed side of the same ravine as the one that yielded the coin moulds, but from a level several feet lower and at some distance to one side. The texture of the cloth (enlarged about 4½ diameters in Fig. 8) is finer than in the fragment figured by Mackay. But the workmanship of the pot is crude, the glaze having failed to cover the lower margin of the pot. Here small patches of the naked surface of the paste have a pale pink colour. The thick, uneven bottom is deeply pitted with the marks of finger-tips, evidently made while the paste was being shaped and provided with its cloth lining before the pot was put into the kiln. The freshly broken surface is opaque, white and finely granular; it shows no blow-holes due to gas.

The resemblance with some of the glazed pots from Mohenjo-Daro appeared so striking that I sent a few fragments to Mr. Sana Ullah with a request that he should compare the materials with those from Sind, which he had previously analysed. He reports that the Rohtak fragments are composed of a substance quite different from the faience of Mohenjo-Daro. But he has kindly promised to submit my fragments to a detailed analysis for comparison with the vitreous paste of which some of the Mohenjo-Daro articles were made.

(*e*) *Ink* (?).—In the bottom of this pot a minute quantity of a black ink-like substance was discovered (see Fig. 7) which after reading Sana Ullah's account[11] I had suspected to be *śilājīt*, a natural exudation from the rocks still used as a drug in Indian medicine. The amount available was hardly enough for a quantitative test, but I am deeply indebted to my colleague Dr. A. C. Chatterji for a qualitative analysis of 0·02 gm. of the substance. He reports that while he found in it most of the constituents of *śilājīt*, it contained no water, nor magnesium; and he says that a similar result might be given by lamp-black mixed with earth. Mr. Sana Ullah who very kindly examined another sample confirms this view by saying that it is certainly not *śilājīt*, but "carbon (probably lamp-black) mixed with mineral impurities". He adds that an exactly similar material has been found in copper inkstands at Taxila. If the black substance is ink (and this small pot might certainly do well for an inkstand), it might indicate that the pot is only slightly older than the coin moulds, because the oldest evidence of the actual use of ink in India dates at most to the 2nd or 3rd century B.C.[12] At the same time, there is nothing strained in the idea that the use of charcoal or soot was known to the Chalcolithic people, who knew the use of the paint brush for drawing lines on pottery.[13] It is the evidence from the structure and composition of the pot itself that must supply the main clue to the age and for this we must await the analysis which Mr. Sana Ullah has kindly promised.

(*f*) *Shell bead.*—Finally, I ought to mention (although I did not collect it myself) a shell bead, carved in the shape of a date (Figs. 9, 10). It was given me by a villager at Khokra Kot, who said it was picked up on the mound, and there seems no reason to disbelieve him. The enlarged end view (Fig. 10) shows the spirally placed laminæ: the bead was evidently carved out of the columella of a massive (marine) gasteropod shell; the minute structure is identical with that of beads (*e.g.*, No. R. 3884) and other shell articles from Harappa which through the courtesy of the curator, Dr. Sita Ram, I was able to compare in the Central Museum, Lahore.

Ordinarily one should not attach an age value to a relic of which the source and stratigraphical position is unknown. For this reason no definite opinion can be expressed as to the age of this solitary specimen. If I draw attention to it here it is not as proof of a prehistoric age but as a further ground for my suspicion that well-directed excavation of the deeper strata, which would probably be more accessible at Khokra Kot than they were on the banks of the Indus, will yield relics as old as those at Harappa or Mohenjo-Daro.

The resemblance with some of the beads from these localities is so close that our specimen might equally well have come from

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[10] See Marshall, p. 570, pl. CLVII, 14.

[11] Marshall, pp. 689–690.

[12] See Bühler, *Indian Palæography*, 1904, pp. 5, 6, 97.

[13] Marshall, pp. 319–320.

either of these places. But of course the illiterate villager could hardly have brought or obtained it from these far off places which, as already stated, are about 250 and 560 miles away as the crow flies. Sir John Marshall and others have already suggested that in all probability the "Indus" culture extended to other parts of India. And there would seem to have been no more likely direction for its spread than into the fertile plains of the Jumna and the Ganges.

In my full paper I shall acknowledge all the help so generously given me by a number of kind friends, but apart from those already named above I would like to record my special thanks to my assistant Mr. K. N. Kaul, M.Sc., for the excellent photographs here reproduced.

May 8, 1936.

Postscript.—During a second visit to Khokra Kot to-day a further collection of *several thousand* fragments of coin-moulds similar to those described above, was made.

Rohtak, 10*th May*, 1936. B. S.

Fluorescence in Ultra-Violet Light as an Aid to Chemical Analysis.

By Julius Grant, Ph.D., M.Sc., F.I.C.,

Chessington Avenue, Finchley N. 3, London.

THE more spectacular applications of this method are now well known. Ultra-violet light now ranks as one of the "mystery rays" concerning which the man in the street is duly informed when a forgery or similar crime is "in the news", and numerous workers interested in the various ramifications of science applied to industry have put on record their belief as to the value of the method.

One aspect of the subject, however, does not appear to have received quite the attention it deserves, and this is the application of the method to what we may term ordinary chemical analyses, in order to distinguish them from the more or less specialised or empirical methods used in connexion with industrial work. In many cases these provide very sensitive and specific tests, some of which may be used quantitatively, and it is felt that once the possibilities are better known they will give the analyst yet another string to his bow.

The principle of the method of fluorescence analysis is now so well known that the shortest introductory description will suffice. In brief, substances which appear identical in ordinary daylight or artificial light may emit a characteristic fluorescence in ultra-violet light which not only enables them to be identified, but also supplies information regarding their nature and origin; hence the value of one of the applications of this method in industrial work, *e.g.*, the checking of samples against deliveries. This fluorescence may be so vivid as to be apparent even when minute quantities of material are present, and hence again its uses in criminological work, *e.g.*, for the detection of forgeries and erasures, etc. In chemical analysis, however, the underlying principles are rather different and they may be summarised as follows:—

(1) Production or disappearance of fluorescence.

(*a*) Thus, two non-fluorescent substances (one a reagent and one the unknown) are caused to react so as to produce an end-product which fluoresces visibly even if the quantities involved are very small.

(*b*) Conversely the fluorescence of a substance or a reagent may be destroyed by the reaction. The obvious disadvantages of this method are that it is less sensitive and less specific than (*a*).

(*c*) Allied with (*b*) is the method based on the property of certain ions of inhibiting in a specific way the fluorescence of a substance without reacting with it chemically. Such inhibition may therefore be used as a test for the inhibiting substance, and if, as is usually the case, the minimum amounts necessary for the purpose are known, the method enables one to say whether the quantity present is over or above that amount.

(2) The change in the colour or intensity of the fluorescence of a substance may be used to indicate the end-point of a quantitative reaction in which it does not of necessity participate. In other words, the substance plays a part similar to that of the ordinary indicator used in volumetric analysis.

(*a*) The substance to be determined may be its own indicator (just as the disappearance of the colour of potassium permanganate indicates that an oxidation-reduction reaction is complete).

(b) The fluorescent substance is added to the reacting mixture. This is the usual procedure.

For the sake of completeness it should be mentioned that absorption spectrophotometry, using ultra-violet light, is a valuable aid to the identification and determination of many substances (especially organic compounds). The method hardly falls within the scope of this article, but it is completely analogous in principle with the use of the visible spectrum for the same purpose. It may also be mentioned that the light from the mercury arc is of great assistance in making certain determinations by colorimetric methods. The determination of bismuth, cadmium or antimony[1] by the sulphide method may be cited as examples.

APPARATUS AND TECHNIQUE.

Both apparatus and technique are very simple. The mercury arc lamp, which is the most popular source of ultra-violet light, may conveniently be used, and it is an advantage to choose a model which is supported or hung at such a height as to allow room for manipulation underneath it. This is a point worthy of consideration when volumetric reactions are being carried out, because the burette must be held over the titration-vessel and the latter must be in the full beam of the light. If, therefore, a lamp can be chosen with a window on the side instead of in the base, it is all to the good.

Visible light should of course be removed from the radiation by means of a Wood's glass filter, and in all cases the best results are achieved by working in a darkened room. The ultra-violet light provides sufficient illumination for manipulations, and it is even possible to read a burette with the usual degree of accuracy if the fluorescent quinine sulphate float described by the writer[2] is used; similarly, pipettes and other instruments may be rendered visible by smearing them with vaseline, which is brilliantly fluorescent.

Containers should be non-fluorescent and quartz is the ideal material. If the lamp has a window in the base it is best to use as a reaction vessel a basin or dish placed under it, because the light can then fall on the contents without striking the walls of the container. Some drop-reactions are conveniently carried out by the spotting method on non-fluorescent filter paper. Reference must be made to the literature[3] for further details of technique.

APPLICATIONS.

It is not possible to deal exhaustively with all the possibilities of the method, but the examples which follow have been chosen so as to indicate some of the most typical and important applications.

Inorganic Chemistry.—The conversion of fluorescein into eosin by the action of *bromine* provides a very sensitive test for this element (or for bromides) owing to the change in the nature of the fluorescence which results; this reaction is conveniently carried out on a filter-paper, the bromine being directed through a capillary tube on to a dried spot of fluorescein. Similarly the yellow fluorescence of resorufin may be destroyed by bromine although this test is also sensitive to chlorine.

The Gutzeit test for *arsenic* provides an interesting example of the use of fluorescence to increase the sensitiveness of a reaction, because colorations on the mercuric chloride paper corresponding with 0·01 to 0·001 mgrm. of arsenic are rendered visible, although they cannot be seen in ordinary light.

The vivid fluorescence of quinine sulphate is the basis of a number of useful tests involving, directly or indirectly, the formation of the sulphate ion. The detection of *sulphites*[4] and *sulphides*[5] will serve as examples, the substance under examination being heated with acid in a stream of carbon dioxide (to prevent premature oxidation), and the gas evolved being passed into bromine water or, if sulphides only are to be detected, into cold hydrogen peroxide. In each case a speck of quinine is added to the reagent, and the formation of a trace of sulphate causes it to fluoresce vividly. It has been found[6] that dilutions so great as $1 : 0 \cdot 5 \times 10^8$ of quinine sulphate has a visible fluorescence, and if the above reaction is carried out on the micro-scale, 0·25 and 0·1 mgrm. of sulphur as SO_2 and S, respectively, is detectable. It is of course important that the oxidising reagent should not fluoresce with quinine before the reaction

[1] *Cf.* J. Grant, *Analyst*, 1928, **53**, 626.

[2] *Jour. Sci. Inst.*, 1932, **9**, 359.

[3] *Cf.* M. Haitinger, *Mikrochemie*, 1935, **16**, 321; Radley and Grant, *Fluorescence Analysis in Ultra-Violet Light*, 1935.

[4] See J. Grant and J. H. W. Booth, *Analyst*, 1932, **57**, 514.

[5] See J. Grant and H. P. Smith, *id.*, 1934, **59**, 749.

[6] Grant, *loc. cit.*

starts, and although no difficulty is usually experienced with bromine water it may be necessary to test several supplies of hydrogen peroxide. Other uses of quinine sulphate are dealt with in the sections on organic substances and indicators.

Uranyl salts have a strong and characteristic fluorescence, but they cannot safely be used directly for this type of work because they are affected by the presence of other compounds. The work of Y. Volmar and V. Mathis[7] has shown that of the inorganic ions Cl′, Br′, CN′, S″, SCN′ and $FeCy_6''''$ will inactivate uranyl sulphate to an extent which varies inversely with the chemical equivalent, and that a definite minimum quantity is required to produce the required effect. The method may therefore be used to detect such ions, and under suitable conditions it is even possible to say whether more than the minimum quantity is present.

The *bead tests* yield additional information if they are inspected in ultra-violet light. Borax, sodium metaphosphate and calcium fluoride beads have all been used in this way, some of the most striking results being obtained with uranium salts (which give a yellow bead) and the rare earths; in the latter case cerium, samarium, niobium, terbium, thulmium and europium may be identified, even if present in very small quantities.

Among the *miscellaneous fluorescence reactions* of inorganic compounds may be mentioned the tetrahydroxy flavonal test for beryllium; the reaction of boric acid with fluorescein (sensitive to 0·02 mgrm.); the distinction of nitrites from nitrates by the red fluorescence they produce with certain dyes; the use of *o*-hydroxy quinoline, which forms fluorescent compounds with a number of metals (*e.g.*, zinc, magnesium or cadmium); and the dimethyl glyoxime test for rhenium.

Organic Chemistry.—The uses of *quinine* as an indicator of inorganic reactions have already been referred to, but its own fluorescence also enables it to be determined. This provides one of the best examples of this type of reaction in organic chemistry. The determination may be made by one of two methods according to the amount present, *viz.*—

(*a*) *Micro Methods.*—J. R. Nicholls[8] matches the fluorescence of one of a series of standards containing known quantities of quinine in the presence of sulphuric acid, against that of the sample, and has obtained very accurate results for quantities of the order of 0·1 to 0·2 grm. per ml.

(*b*) *Macro Method.*—The writer[9] has found that if the quinine is dissolved in a known amount of 0·01 *N* sulphuric acid, the excess may be back-titrated with 0·01 *N* alkali with an accuracy of 0·1 ml., the end-point being given by the change in the shade of the fluorescence. The advantages of the method are outlined below under the heading of fluorescent indicators.

There are a number of useful miscellaneous tests for organic compounds. Thus, a 10 per cent. solution of *p*-dimethyl aminobenzaldehyde is a general reagent for many *hydrocarbons*; thus, for example, it produces a red-brown, grey-blue, brilliant blue and deep-red fluorescence with benzene, anthracene, quinoline and quinone, respectively.

Among the reactions for *alcohols* mention may be made of the distinction of α- from β-naphthol by the green fluorescence obtained with a mixture of acetic and sulphuric acids in the presence of the latter (sensitiveness 1 in 100,000) but not the former. Naphthoresorcinol is a reagent for glyoxal, and glycerol is frequently detected in foodstuffs by oxidation with bromine water to dihydroxyacetone which can then be made to fluoresce with a solution of β-naphthol in sulphuric acid.

Reactions are available for most of the *sugars*. Thus, a green fluorescence is produced with dextrose by β-naphthol, and with arabinose by zirconium oxychloride, while resorcinol in hydrochloric acid is a reagent both for fructose and sucrose (*e.g.*, in milk), a green and a red coloration being obtained, respectively.

Interesting reactions for *organic acids* are the orcinol test for malic acid (which is used as test for apple pulps in jam); the blue colour produced with ββ-dinaphthol in the presence of 1 part in 50,000 of tartaric acid; and the use of *o*-oxydiphenyl in sulphuric acid as a test for lactic acid. The list might be extended considerably to include amino-compounds, sterols, higher alcohols, etc. Mention should also be made of the detection and determination of certain *alkaloids* by the Volmar-Mathis method

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[7] *Bull. Soc. Chim.*, 1933, **53**, 385; **54**, 1266.

[8] *Analyst*, 1934, **59**, 277.

[9] *id.*, 1931, **56**, 653.

(*loc. cit.*), *i.e.*, by observing the concentration necessary to inhibit the fluorescence of uranium salts.

Fluorescence Indicators.—As already pointed out these are now playing an increasingly important part in analysis. The advantages they offer over ordinary indicators are :—(*a*) increased sensitiveness owing to the high dilutions at which the fluorescence is visible ; (*b*) they may frequently be used in turbid and/or coloured solutions ; (*c*) owing to the fact that they are used in much smaller quantities than the ordinary indicators, the error normally involved in the latter case (owing to combination of the indicator with either of the reactants) is avoided. The writer has also found that if a little saponin is added to a particularly coloured or turbid solution and the titration is carried out in a conical flask, then the end-point may conveniently be shown by the change in fluorescence of the froth. Fluorescent indicators may be classified as follows :—

(*a*) *Acid-Alkali Indicators.*—These change in fluorescence according to the *p*H value of the medium in which they occur and they may be chosen, just as with ordinary indicators, so that the end-point corresponds with any desired *p*H value. Quinine (*p*H 5·9—6·1 and 9·5—10·0) is the most familiar example, but it is now possible to cover the whole range of *p*H values. Thus eosin serves between 2·5 and 4·5 ; resorufin, 4·4—6·4 ; umbelliferone, 6·5—7·6 ; and coumarin, 10·0 — 12·0, etc.

(*b*) *Precipitation Reactions.*—Adsorption indicators are now used to indicate the end-points of these titrations (*e.g.*, silver nitrate against a halide), and if certain fluorescent substances (*e.g*, Rhodamine) are used for the purpose an increased sensitiveness is obtainable.

(*c*) *Oxidation-Reduction Reactions.*—The fluorescence of certain substances (*e.g.*, resazurin and resorufin, see *supra*) is destroyed by the action of reducing or oxidising agents, and this serves as an end-point for the reactions concerned.

Further examples and details concerning all the above types of reaction are given in the literature (*cf.* Radley and Grant, *loc. cit.*[3]).

The Helium Content of the Atmosphere.

By Prof. F. A. Paneth,
Imperial College of Science, London, S.W. 7.

"AIR is a physical mixture with the definiteness of composition of a chemical compound." This was the conclusion reached by Francis G. Benedict of the Carnegie Institution (Washington) in 1912, after a series of very accurate analyses of the oxygen content of about 200 air samples which were taken during a period of 8 months at Boston and at several places over the ocean. The variations of the mean value (20·952%) were certainly less than ± 0·05%, in spite of all possible alteration in weather conditions, and although the experiments were made before, during and after the vegetative season. This constancy of the atmosphere's composition was later confirmed by A. Krogh (Copenhagen, 1919). Krogh states that the combustion of fuel and the respiratory exchange of organisms must cause a production of carbon dioxide which is similar in amount to the quantity of oxygen used up, while the assimilation of plants must diminish the carbon dioxide to an extent equal to the increase in oxygen ; but that all variations in the oxygen and carbon dioxide percentages due to combustion, respiratory exchange or assimilation should leave the "nitrogen" percentage practically unaltered. (Under "nitrogen" is understood nitrogen *plus* argon and the other rare gases.) The percentage of "nitrogen" (79·0215) is considered by Krogh to be a geophysical constant, which does not vary by more than ± 0·003%, if at all. As to the carbon dioxide content of the atmosphere, it is obvious that this can vary considerably and attain a multiple of its usual value where processes of combustion or respiration are going on in closed, or badly ventilated, rooms. On the other hand, in the open air the variations are very small, as can be gathered from the constancy of the oxygen percentage found by Benedict, and as has been directly proved by him and by J. S. Haldane in Oxford, who found that the deviations from the average value of 0·03% carbon dioxide never exceed 0·005%.

Although these careful analyses are quite convincing as far as they go we may never-

theless ask whether the claim that the composition of the open air can be considered as constant as that of a chemical compound is strictly justified. In the first place we do not know that the oxygen content of the air is not subject to variations when larger periods of time are taken into account. As there is a constant absorption of the oxygen by rocks which by their disintegration become freshly exposed to the atmosphere, it is quite likely that after a century a repetition of analyses of the oxygen- and nitrogen-content will show figures different from those of to-day. (The analyses made 100 years or so ago are not nearly accurate enough to provide a basis for comparison.)

While this doubt about the constancy of the air's composition with time can at present be only a surmise we may be almost certain that there is a variation with height. So far nothing definite is known about the composition of the higher layers of the stratosphere, but it is at least very likely that large scale mixing ceases at a certain height, and then the gravitational field must effect a separation of the constituents of the air in such a way as to concentrate the heavier carbon dioxide, argon and oxygen in the lower part, leaving the main amount of the lighter nitrogen for the higher layers.

So far we have considered only the main constituents of the air. From the constancy of the oxygen or "nitrogen" content one can, of course, draw no conclusions as to those gases which are too scarce to be able to effect appreciably the oxygen or "nitrogen" percentage even if they themselves undergo variations by several times their own amounts. I refer here to the rare gases neon, helium, krypton and xenon, which are present in about the following quantities:

Neon	..	..	0·0018 %
Helium	..	..	0·0005 %
Krypton	..	..	0·0001 %
Xenon	..	..	0·00001 %.

The most interesting of them is helium, since it is the only rare gas of the atmosphere which is to be found also in the earth. It is formed as a product of radioactive disintegration in all rocks and minerals which contain traces of uranium or thorium. In geological times large quantities of helium have slowly escaped from the rocks into the atmosphere, but much helium has accumulated in the earth's crust, and in certain localities these stores of "fossil" helium are now more or less suddenly leaking into the air, as, for instance in the American oil-fields. It has been calculated that the amount of helium in our atmosphere should be doubled in considerably less than a million years if only the present outflow of helium from the surface of the earth is maintained; since the geological conditions on our earth have probably been fairly constant for many millions of years it is very likely that the only explanation for the low content of helium is a constant escape of the latter from the top of the earth's atmosphere into the void. There is no known reason why these two processes should be of equal efficiency so as to keep the helium content of the air constant, and it may well be that it either increases or decreases as time goes on.

While, thanks to the experimental work mentioned above, we may be quite certain that neither the oxygen nor nitrogen percentage varies appreciably according to the geographic position, nor during a period of a few years, we must admit that in the case of helium both these questions are still open. So far a comparison has never been made of the helium content in different parts of the earth, nor has its constancy in time been tested with any degree of accuracy. We should expect helium to be found in larger concentrations in the neighbourhood of those regions where it escapes from the earth in abnormally high quantities; but recent investigations by Gerling in Russia have revealed only a very slight increase of the (helium + neon) content of the air directly over the areas of oil-fields, while on their boundaries only the normal percentage was found. It seems, therefore, that the mixing of the air by winds prevents the establishing of any larger variations, due to the comparatively small quantities released by oil-fields. It must, on the other hand, be considered doubtful whether the outflow of helium from land and sea is uniform, or the mixing through winds efficient enough to result in an equal distribution of helium all over the earth; we may hope to obtain interesting information about the mixing of the troposphere by an accurate survey of its helium content. As helium is the lightest of the gases of the atmosphere—it is very doubtful whether hydrogen is a constant part of it—the distribution of helium according to height must, in addition, yield valuable information about the question as to where large scale mixing in the

stratosphere ceases and the gravitational separation of the different constituents of the air takes place.

For these reasons we have started a world survey of the helium content of the air. The first condition for a successful investigation was the development of a method which allows of the separation and exact measurement of the helium from a small quantity of air; otherwise the collection of representative samples all over the world and from the stratosphere would involve great expense. My laboratory has been interested in the detection of minute quantities of helium for many years, and thanks to the development of the method, mainly by K. Peters, Wm. D. Urry, and E. Glückauf, we are now able to determine the helium content in 1 c.c. of air with an accuracy of about 1%; this means that variations of the helium content of air which amount only to 5×10^{-6}% of the total gases can be detected.

Our preliminary results show that the helium content of the atmosphere in different parts of the earth is not as constant as the oxygen or nitrogen content is supposed to be. It seems that variations of at least 3% occur right on the surface of the earth and sea. A sample of stratosphere air from 21 km. height over England was collected for us by a sounding balloon, thanks to the collaboration of Sir George Simpson, the Director of the Meteorological Office in London, and showed the still higher surplus of 8%, while samples taken at heights of 16 and 18 km. over England contained no more helium than London air.

Interesting though these results are, the information they provide is not yet sufficient to draw any definite conclusions either concerning the origin of the variations observed on the surface of the earth or as to the state of the stratosphere above 20 km. height. A continuation of the researches on a broader basis is clearly indicated, all the more so as it will form the basis of the further investigation as to whether the helium content is constant in time or not. We have been fortunate in securing the collaboration of meteorologists and chemists in different parts of the world who were kind enough to send us samples of air for analysis; some of them have even promised to obtain for us samples from the stratosphere.

It is very gratifying that our appeal has found such generous response and, in concluding this article, it gives me special pleasure to mention that thanks to the kind interest of the Director-General of the Meteorological Office in Poona, a representative collection of air samples from India, including, besides Poona, the stations of Agra, Karachi, Peshawar, Calcutta, Rangoon and Kodaikanal has been promised to me, and that a few of the samples have already arrived. As the result of such collaboration we hope in a year or so to be in a position to answer some of the interesting questions connected with the distribution of helium in the atmosphere.

Air Survey and Reconnaissance of Indian Forests.

By H. G. Champion, M.A., I.F.S.

Silviculturist, Forest Research Institute, Dehra Dun.

ONE of the first requirements for organising the management of a tract of forest to best advantage is a stock map showing the position and extent of the different types of forest with indications as to their content both in quantity and quality of the important timber species. India was not unduly behindhand in using the new instrument of air survey for this purpose as some 300 sq. miles of forest were surveyed in the Irrawaddy Delta[1] in 1923–24, the Burma Forest Department being fortunate in having in Messrs. C. W. Scott and C. R. Robbins, officers with distinguished records in the Royal Air Force, competent observers to interpret the variations in the vegetation as seen from the aeroplane and reproduced on the photographs. This survey which was considered to be most successful for the purposes (primarily topographical) for which it was carried out, was admittedly a relatively simple proposition over absolutely flat country, with an easily recognised network of waterways and better differentiated types than are often encountered. It was followed in 1934–35 by air photography of about 200 sq. miles and an air reconnaissance of 15,000 sq. miles in South Tenasserim.[2]

[1] Irrawaddy.

[2] *Burma Forest Bulletin* No. 13, C. W. Scott and A. R. Robbins, Rangoon, 1926.

In the later operation 13 different types of forest were mapped on existing topographical survey maps at a cost of Rs. 5–5–0 per sq. mile as compared with an estimated cost of at least Rs. 15 to obtain comparable results on the ground. Since these surveys were made, nothing further is recorded as having been done in Burma, but several trials have been made in different parts of India.

Two of these trials were effected by seizing the opportunity when Land Settlement work with air survey was in progress near forest tracts. The first was in Bengal in 1926–27 when air photographs and maps for the forests of Chittagong and Cox's Bazar were obtained and utilised for working plan purposes:[3] no account of this work appears to have been published. The other was in the United Provinces in February 1931 when sample portions of North Kheri and Pilibhit divisions were mapped from the air at a cost of Rs. 55 per sq. mile.[4]

A more recent instance is that of an air reconnaissance of a very unhealthy tract in the North Godavery division in Madras[5] which was supplemented by some amateur photographic work the results of which are still under consideration. Some observations have also been published on a flight over the forests of the Andaman Islands.[6]

The result of these surveys is the accumulation of a considerable amount of experience, the application of which would result in much more information of the type required by the forest management officer for a given flying time and expense. The selection of the most suitable season is a matter of great importance as most species of trees tend to differ fairly conspicuously from their associates only at some phase of their annual cycle, whether in flower (teak, *Hopea*), new foliage (*Mesua*), old foliage (*sal*, *Anogeissus latifolia*). It is fairly obvious that when trees are leafless, the photographs are almost impossible to decipher. The early morning or the evening is the best time for reconnaissance or photography, the longer shadows greatly helping to bring out differences.

In photographic work, the use of the best type of lens and film is of even greater importance for forest survey than for topographical survey. Systematic trials in Canada[7] have demonstrated that as expected highly sensitive panchromatic film with a green filter gives maximum differentiation of colour of vegetation—colour photography still has considerable progress to make before it can be a practical proposition in this field. Most of the work is done at a height of 6,000 ft. or more the photographs obtained being on a scale of about 6″ to 1 mile, but of course there is much variation according to conditions and requirements. The photographs obtained on the forest surveys referred to above have been found to vary greatly in quality, vibration being perhaps the chief cause. The faster films and lenses now available should largely remedy the trouble.

The relative value of oblique photographs with wider field and less cost, calls for consideration, and undoubtedly in reconnaissance work will meet many requirements: they may be particularly useful in combination with a strip of vertical photographs.

It is, of course, now possible to produce very serviceable contour maps from air photographs (the newly constituted Soil Conservation Service of the United States is doing such work on a very big scale) and as a natural corollary, it should be possible to measure the height of trees. The Canadian worker referred to above[7] claims to have done this within 5% as determined by a ground check. Stereoscopic methods are of course largely used in this class of work.

With present appliances, there are distinct limits to the information which can be obtained from aerial reconnaissance or photographs with regard to the composition of our forests, above all for the more luxuriant types such as the moist tropical evergreen. It is too much to expect to be able to distinguish more than a very strictly limited selection of species from among the very large number contributing to the top storey, whilst often nothing can be seen of the lower tiers of vegetation including the younger trees of the important species concerning (which information is essential to the forester). At the same time, in

[3] "Working Plan for Chittagong division"—not yet published.

[4] "Air Survey of Forests," F. W. Champion, *Indian Forester*, 1933, 12.

[5] "Aerial Reconnaissance in the Forests of Madras," C. C. Wilson, *Indian Forester*, 1935, 765.

[6] "A Flight over the Andamans," A. D. B., *Indian Forester*, 1932, 469.

[7] "Aerial Photography–method of determining timber species," H. C. Ryker, *Timberman*, 1933, **39.**

combination with the always necessary ground survey of representative areas, it can often give a large proportion of the information required more quickly and more cheaply than the usual ground work, and even on occasion[8] reveal features which may easily be overlooked on the ground.

It remains to mention a few other aspects of such work. Air survey may be of great value in detecting epidemic outbreaks of injurious insects, in determining their extent and spread, and in combating them—for this also has been done from the air in Europe and America. It may also be of the greatest value in recording gradual changes in density and nature of vegetation occurring naturally and though the influence of such agencies as fellings, grazing or burning, air photographs being incomparably superior to ground photographs for this purpose.[4]

In the less accessible tracts such as the Chittagong Hills where shifting cultivation is liable to encroach on reserved forests, rapid periodical reconnaissance from the air can save months of travelling.

Finally, the distribution of trees and forests is closely related to that of soil and underlying rock and work in other countries has shewn that air survey is a great help in mapping their distribution also.[9]

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[8] "Air Reconnaissance of the Forests of S. Tenasserim," W. A. Robertson, *Indian Forester*, 1926, 131.

[9] "Air Survey in relation to Soil Survey," R. Bourne, *Imperial Bureau of Soil Science, Technical Communication*, 1931, **19**.

Obituary.

M. P. Venkatarama Iyer, M.Sc. (1902—1936)

IT is with feelings of deep sorrow that we have to record the death, from typhoid fever, of Mr. M. P. Venkatarama Iyer, Lecturer in Chemistry, Central College, University of Mysore, on 27th April.

Mr. Venkatarama Iyer had a distinguished career as a student of the University of Mysore and took the first rank in the B.Sc. degree examination, 1924. Later, he secured the M.Sc. degree of the Calcutta University, with distinction. He carried out post-graduate research in the General and Organic Chemistry Department of the Indian Institute of Science and was appointed Lecturer in Chemistry at the Central College, Bangalore, in 1927. He was recently elected a Fellow of the Indian Academy of Sciences.

Besides being a very capable teacher, Mr. Iyer was an enthusiastic research worker, his special field of study being colloid chemistry, having been initiated into research first by Prof. F. L. Usher and later by Prof. J. N. Mukherjee. As a teacher he was loved by his students both for his learning and for the charm of his personality. He utilised all his spare time for research and published a number of papers and at the time of his last illness, he was busy preparing his thesis for the Doctorate in Science. His recent work in electrometric studies on the formation and stability of colloids which is awaiting publication throws considerable light on the vexed question of the formation of basic salts. Mr. Iyer was an enthusiast of a rare order, and there was hardly any scientific meeting at Bangalore which he missed. Most unassuming in his bearing, and possessing a critical faculty, his presence was courted by his colleagues at all discussions. He was responsible for organising a *study circle* composed of his colleagues in the Central College and in the Indian Institute of Science, for informal and intimate discussion of problems in physical chemistry. Mr. Venkatarama Iyer was keenly interested in *Current Science* and was a regular contributor to the Reviews and Research Notes sections of the Journal. In his untimely death at the very early age of 34, India, in general, and the University of Mysore, in particular, has lost a devoted research worker of great promise.

We regret to record the following deaths:—

SIR RAJENDRA NATH MOOKERJEE, K.C.I.E., K.C.V.O., one of India's foremost industrial magnates, on May 15, at the age of 82.

MR. CHARLES A. KING, B.SC., M.I.M.E., M.I.E., Principal, Engineering College, and Jodhpur Hardinge Professor of Technology, Benares Hindu University, on May 19.

Centenaries in May 1936.

Lockyer, Joseph Norman, 1836-1920.

SIR NORMAN LOCKYER, the pioneer astrophysicist, was born at Rugby on May 17, 1836. Sir Norman Lockyer was not the product of a University. After receiving his early education in some private schools, he obtained a clerkship in War Office in his 21st year. But all his leisure and all his personal resources were devoted to scientific pursuits. He bought a reflecting telescope of 6¼ inches aperture and attaching a small spectroscope to it, began to observe the sunspots and to study planetary surfaces.

HIS FIRST CONTRIBUTIONS.

His first two papers were contributed to the *Memoirs* (1863) and the *Monthly Notices* (1865) respectively of the Royal Astronomical Society. They were entitled "Observations on the Planet Mars" and "Observations of a Sun Spot". His first contribution to the *Proceedings of the Royal Society* was made in 1866 and was entitled "Spectroscopic Observations of the Sun".

DISCOVERY OF THE CHROMOSPHERE.

These preliminary spectroscopic observations of the sunspots whetted the appetite of Lockyer to explore the solar envelopes and in particular to determine the precise nature of the Solar prominences photographed in the total solar eclipse of 1860. This being his first major discovery, we may quote his own words in describing them. "A great dispersion was required....for the spectra of the red flames....I made my first application to the Government Grant Committee for money to provide a solar spectroscope of large dispersion to attach to the equatorial. The grant was approved; but, in consequence of delays, the instrument did not reach me till October, 1868. On October 20, I saw the bright lines, as I had anticipated in 1866. On November 5, I discovered that the prominences were but higher waves in a sea which enveloped the photosphere. This new envelope I named the *Chromosphere.*"

A DRAMATIC COINCIDENCE.

The honour of this discovery, he had to share with the French astronomer Dr. P. J. C. Janssen, who had hit upon the same observations in the total solar eclipse of August 18 at Guntur, in Madras. Janssen sent a communication on the subject to the Academy of Sciences in Paris. By a dramatic coincidence it arrived in time to be read at the same session on October 26, as Lockyer's account. There was however no manifestation of petty jealousy or stupid claims of priority. To commemorate the discovery, the Academy of Sciences caused a medal to be struck which bears the effigies both of Janssen and of Lockyer.

DISCOVERY OF HELIUM.

The study of the solar spectrum obtained in 1868 led Lockyer to yet another epoch-making discovery. This discovery was made in collaboration with Dr. Frankland. In their joint paper to the *Proceedings of the Royal Society* of February 11, 1867, they start with the conjecture "There is a line near D visible in the spectrum of the Chromosphere to which there is no corresponding Fraunhofer line". Having made experiments on hydrogen, sodium and iodine under various conditions of pressure and temperature, Lockyer says, "We had to do with an element which we could not get in our laboratories, and therefore I took upon myself the responsibility of coining the word *Helium.*" It was not till 1894 that Sir William Ramsay detected helium in the air.

GETS A SCIENTIFIC POSITION.

These discoveries created great enthusiasm among astronomers and promoted throughout the whole world the foundation of astrophysical observatories. They also led to a due recognition of the scientific talent of Lockyer and to his transfer from clerkship to the Science and Art Department in 1875 and, on the foundation of the Royal College of Science in 1890, to the Directorship of the Solar Physics Observatory and the Professorship of Astronomical Physics. Between 1870 and 1905 he conducted eight solar expeditions. This brought him to India in 1871. He observed the total solar eclipse of 12th December 1871 at Bekul, 25 miles from Mangalore. He retired from the professorship in 1913 and established a private observatory, which is still flourishing.

FOUNDS *Nature*.

As early as 1869, having gained considerable experience as the science editor of a number of weeklies, Lockyer got the support of Alexander Macmillan and founded the well-known scientific weekly, *Nature*;

and brought out its first number on November 4, 1869. It required the rare combination of scientific authority, untiring energy, wise judgment, and business aptitude to float a periodical of that nature. In what abundance Lockyer possessed these attributes and how consistently they had been made manifest in the pages of *Nature* can be realised if we remember that Lockyer continued to be its editor for full 51 years *i.e.*, till his death and that even now, in the 137th volume, which is current, *Nature* maintains the very form and character, which was given to its first issue by its founder—the same general arrangement, the same sequence of subject-matter, the same number of pages and the same style of type. It still sheds the same clear and steady light on the pathway of research. It still continues to maintain a lucid record of modern discovery and to stimulate the appetite for knowledge in many minds.

HIS ACHIEVEMENT.

Apart from his founding *Nature* and the School of Astrophysics, he had contributed nearly 200 memoirs of his own. His personal interest led him also to extensive investigation in meteorology and Egyptian archæology.

Lockyer's work received due recognition. He was elected a Fellow of the Royal Society in 1869 and he later became member of many learned bodies in many countries. He was Rede Lecturer at Cambridge in 1871 and Bakerian Lecturer in 1874. In 1894 he received the C. B. and he was created K. C. B. in 1897. He was President of the British Association in 1903–04. His stirring presidential address on "The influence of brain power on history" produced a great impression and eventuated in the foundation of the British Science Guild, for the furtherance of scientific interests. Perhaps his greatest service to science in general was his successful advocacy of the claims of science in modern polity.

Full of honours and full of age, Lockyer died at the Hill Observatory on 17th August 1920.

S. R. RANGANATHAN.

Webb, Francis William, 1836-1906.

F. W. WEBB, the British locomotive engineer, was born on 21st May 1836. Showing at an early age a liking for mechanical pursuits, he became at fifteen a pupil of Francis Trevithick, then locomotive superintendent of the London and North-Western Railway. He was associated with that Railway for life, for, he eventually retired in December 1902 as the Chief Mechanical Engineer and Locomotive Superintendent of that Railway.

INVENTS COMPOUND LOCOMOTIVES.

He was a prolific inventor and took out many patents in the design and construction of locomotives and other items such as the steel sleeper, the electric train-staff and the electrical working of points and signals. But his name is chiefly associated with the compound locomotive. Webb began work on the compound locomotive in 1878. The Experiment (1882), the Dreadnaught (1884), the Teutonic (1889), the Greater Britain (1891) and the Diamond Jubilee (1897) are some of his well-known designs. Some of these engines were exhibited at the World Fair, Chicago, in 1893 and at the Paris Exhibition of 1900. A large number of these are still at work. Nearly 4,000 locomotives were constructed under his supervision.

It is of interest to us to note that ten of Webb's Dreadnaught engines were imported in 1884 for service in the Oudh and Rohilkhund State Railway.

CONCLUSION.

Mr. Webb was elected an Associate of the Institution of Civil Engineers in 1865 and he was made a Member in 1872. In 1900, he was elected one of its Vice-Presidents.

He died at Bournemouth on 4th June 1906. By his will he left £10,000 to found a nursing home at Crewe and £50,000 to found an orphanage for children of deceased employees of his Railway.

S. R. RANGANATHAN.

Letters to the Editor.

CONTENTS.

Light Absorption and Chemical Reactivity.

SOMETIME ago Dhar and Bhargava[1] recorded some experiments on the absorption of halogen molecules in the vapour state in the presence of various gases and concluded, that the presence of reactive gases changes the absorption. Already in a discussion at the meeting of the Science Congress, 1935, it was remarked by one of us, that the observed effect may not be a new photochemical effect at all but a simple pressure effect, as well known in band spectroscopy. Subsequently we have investigated the absorption spectrum of bromine in the presence of various gases from this point of view and think it desirable to publish these results now, on account of a recent paper of Dhar and Bhargava,[2] which again attributes the broadening of the absorption region to the reactivity of the gases concerned.

Dhar and Bhargava used the copper or iron arc as a source of light and extremely long absorbing layers of 80 cm. length with the result, that the plates simply became blank in the region of selective absorption. In other words, they utilised the threshold value of the plate as an indicator of absorption. Since this depends on various factors, *e.g.*, the time of developing, and the arc is a very unstable source of light, we have adopted another method which enables us to make quantitative measurements. Taking the same pressures as Dhar and collaborators, we used an 8-volt straight filament bulb run from an accumulator with 10 volts during the exposure time, and absorption cells of 1 cm. length only. In this way the absorbed region of the spectrum was weakened and a quantitative comparison between the various spectra was possible. This was done by measuring the density of the plates by means of the recording microphotometer.

We find, that the effect closely resembles the pressure effect, well known in absorption spectroscopy and that it obtains not only in the presence of additional gases, which are able to react with bromine like hydrogen or alcohol, but also in the presence of inactive gases like CO_2 or N_2 and the same obtains in the absence of foreign gases simply by an increase of the vapour pressure of bromine itself. There is little doubt, that this effect is due to an increase of the number of Br_2 molecules in excited vibrational levels of the ground state on account of the increase of vapour pressure and the number of collisions. From considerations of the Franck-Condon Diagram it is evident, that the energy difference between the two $U:r$ curves is changed for such molecules as compared with those in the lowest state of vibration. As could be expected from the particular position of the potential curves of the two electronic terms in question, the band

system contributes mainly to the change of the value of the absorption coefficient at the long-wave side, the continuum mainly to that at the short-wave side. The contribution of the continuum is much larger than that of the band system on account of the steep slope of the upper $U : r$ curve for this region.

Similar pressure effects have been studied quantitatively by Kondratjew and Polak[3] with whose results ours agree. It appears therefore unnecessary to go into the details of these experiments at greater length, but attention should be drawn to the fact, that the change of the absorption coefficient with pressure may be understood without resort to the reactivity of the gases.

C. M. BHASKER RAO.
R. SAMUEL.

Department of Physics,
Muslim University,
Aligarh.
April, 25, 1936.

[1] N. R. Dhar and P. N. Bhargava, *Nature*, Dec. 1, 1934.

[2] N. R. Dhar and P. N. Bhargava, *Ind. J. Phys.*, 1936, **19**, 43.

[3] V. Kondratjew and L. Polak, *Phys. Zs.* (*Sowjetunion*), 1933, **4**, 764 and literature mentioned there.

On the Constitution of Formic Acid and Formates.

FURTHER to my communication[1] on the subject I wish to add the following. I have since been in touch with Prof. Wheeler, who has very kindly given me full details of his calculations of parachor values which I quote for convenience:—

C, 4·8; H attached to carbon, 17·1; H attached to oxygen, 11·3; O_2 double bond in acids, 60·0; Total, 93·2.

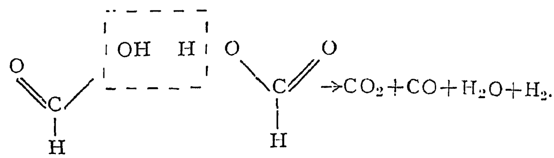
In this calculation it will be seen that Prof. Wheeler, while adopting Sugden's system for the greater part, has taken in places Mumford's values. For example, Sugden's system does not, to my knowledge, differentiate between a hydrogen attached to carbon and that attached to oxygen. Further Hunter and Mass[2] adopting Sugden's data calculate the parachor value of 102·2 for formic acid of the usual formula, which is certainly far greater than the one observed. My conclusions based on parachor values do need no alteration.

Further support for the view, that the H of CH in formic acid is active is available in the relative rate of decomposition on catalytic surfaces. Formic acid decomposes at 280° C. on glass surfaces according to the scheme

$$H{\cdot}COOH \nearrow CO + H_2O + 16{,}000 \text{ cals.} \quad .. \quad (1)$$
$$H{\cdot}COOH \searrow CO_2 + H_2 + 28{,}000 \text{ cals.} \quad .. \quad (2)$$

and the rates of decomposition, provided no other factor comes into play, should be in the ratio of $e^{-\frac{16000}{RT}} \div e^{-\frac{28000}{RT}} = e^{+12}$.

Actually it has been shewn by Hinshelwood and Topley[3] that the two reactions proceed with *equal rates* which becomes possible, if the H of the CH group could be adsorbed on the glass surface. Thus



R. M. HALASYAM.

3, Y. M. I. A. Buildings,
Armenian Street, Madras.

[1] *Curr. Sci.*, 1936, **4**, 651.

[2] *Jour. Amer. Chem. Soc.*, 1929, **51**, 153.

[3] *Proc. Roy. Soc.*, 1922, **100** (**A**), 575.

Constitution of Formic Acid and Formates.

Isosterism.—This term seems to have been first used by Langmuir.[1] He says "Co-molecules are isosteric if they contain the same number and arrangement of electrons. The molecules of isosteres must, therefore, contain the same number of atoms." Based on this conception he deduces that "when isosteric co-molecules are also isoelectric, that is, when they have the same total charge, all their physical properties should be closely similar." In the case of solid substances, crystal form being one of the characteristic physical properties, isoelectric isosteres should be isomorphous and they have been shown to be so.

Langmuir's idea of isosterism has been correctly used by many with useful results. But there are cases where the term "isosteric" has been wrongly employed and confused with "isoelectronic," that is, containing the same number of electrons.[2] The formate ion $[CHO_2]^-$ whatever structure it may be given, cannot be isosteric with the nitrite ion $[NO_2]^-$ since they do not contain the same number of atoms and the deduction of Ray and Sarkar[3] that their salts should be isomorphic is therefore wrong.

Isomorphism.—Unless this phenomenon is understood and studied correctly it cannot be used as a help in elucidating the structure of compounds. A. E. H. Tutton[4] writes, "An isomorphous series may be defined as one the members of which have some definite chemical analogy and crystallise in the same system and class of symmetry and which develop the same form, the faces of which are inclined at angles which only differ by an amount not exceeding two and a half degrees, the amount being less the greater the symmetry." The first requisite of isomorphism is therefore very close similarity in crystal form. The following data taken from P. Groth's *Chemische Krystallographie*[5] will show how fundamentally different the structures of Nitrites and Formates are:

	Nitrite.	*Formate.*
Sodium	Rhombic	Monoclinic Prismatic
Calcium	Hexagonal	Rhombic Bisphenoidal
Strontium	Hexagonal	Rhombic Bisphenoidal
Barium	Hexagonal	Rhombic Bisphenoidal

Mixed crystal formation.—This can serve as a confirmatory evidence of the existence of isomorphism and not as an independent proof of it. Groth[6] writes, "apparently homogeneous mixed crystals of continuously varying composition are obtainable with substances whose chemical nature is totally different (*i.e.*) the crystals of one substance are capable of taking up another substance not isomorphous with it in varying proportions." Langmuir in the paper already mentioned (p. 1555) says, "The data given in the case of nitrates and chlorates show conclusively in my mind that the formation of mixed crystals often occurs when there is no close resemblance in crystal structure. It seems therefore that this criterion should not be used to indicate similarity in chemical constitution." The only evidence adduced by Ray and Sarkar for the existence of isomorphism between Formates and Nitrites is mixed crystal formation.

It is therefore clear that Halasyam's "unequivocal evidence from Isomorphism of Formates and Nitrites"[7] does not exist.

Parachor.—Halasyam was not correct when he stated that the dihydroxymethylene form was proposed by me to explain the absence of the Raman line or when he calculated the parachor for this form and criticised that it did not agree with the experimental value for formic acid.[7] It was never suggested by me that free formic acid is dihydroxymethylene and he evidently assumed that I did so as otherwise his criticisms were not valid. With a view to clear this misunderstanding a more careful perusal of my first letter[8] was suggested. No objection was raised against the term "labile structure". This form was assumed to be produced in the course of certain reactions. To go further than this at present will not be justifiable.

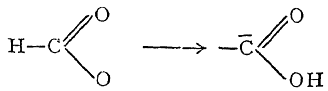
Using either Mumford and Phillips' constants for the parachor of the various atoms and bonds or the more widely accepted values given in Llandolt-Bornstein, formic acid is found to be quite normal and it falls perfectly into line with its homologues. Hence parachor does not support any exceptional formula for formic acid. It will be interesting to note that Mumford and Phillips do not differentiate between single covalent and co-ordinate bonds, both being given the same value ± 0 and hence calculation using their constants gives the same parachor for

$$\underset{\displaystyle\overset{|}{OH}}{H-C}=O \quad \text{or} \quad \underset{\displaystyle\overset{\uparrow}{OH}}{H\leftarrow C}=O. \quad \text{Hence}$$

Halasyam's preference for the Sarkar and Ray formula is not sound. According to the values given in Llandolt-Bornstein, formic acid can have only the ordinary formula and cannot have co-ordinate bonds. This is further supported by other physical properties such as boiling point, dipole moment, heat of formation, etc.

Raman Spectra.—The question of the Raman spectra has been discussed sufficiently by Venkateswaran.[9] No support can be found for the theory of Sarkar and Ray that the ionisable hydrogen is not the hydrogen of the hydroxyl group but the one attached to the carbon. It is therefore gratifying to note that these authors have given it up.[10] They agree that formic acid (liquid and aqueous solution), its esters and its salts in the solid state have the normal structure possessing a C-H bond, but express

the opinion that the salts are abnormal in aqueous solution owing to the ion undergoing the prototropic change.

(I)  (II)

It is possible that isomeric change to form (II) may take place to some extent in the solution and that an equilibrium may exist between (I) and (II). But taking into consideration the relative stability of the two structures it will be difficult to imagine that there could be present more than a very small quantity of (II). Available evidence from Raman spectra indicates that the aqueous solutions of formates are also normal, that is, the formate ion has the C-H bond in the solutions also.

T. R. SESHADRI.

Department of Chemistry,
Andhra University, Waltair.
May 5, 1936.

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[1] "Isomorphism, Isosterism and Covalence," *J.A.C.S.*, 1919, **41**, 1543-1558.

[2] For the use of the word "isoelectronic" see Jevons, *Report on Band Spectra of Diatomic Molecules*, published by the Physical Society, 102.

[3] *Nature*, **133**, 646.

[4] "Crystalline Form and Chemical Constitution," (Macmillan & Co.), 127.

[5] Wilhelm Englemann, Leipzig.

[6] *An Introduction to Chemical Crystallography*, transated by Marshall, 97.

[7] *J. Indian C. S.*, 1935, 813.

[8] *This Journal*, 1935, **3**, 353-4.

[9] *This Journal*, 1936, **4**, 736-7.

[10] *Nature*, 1936, 495.

Bauxite-Gypsum Mixtures at High Temperatures.

THERE are extensive deposits of good quality Bauxite and Gypsum in the neighbourhood of coal mines (The Punjab and C. P.). If a process be found to obtain the two most important commodities alumina and sulphuric acid by making use of the above minerals, India could be made independent of foreign imports of these two chemicals. The import of sulphur in 1934 amounted to 20,000 tons worth Rs. 19 lakhs. Experiments made in the authors' laboratories show that by suitably mixing Bauxite and Gypsum (2 to 5) and heating the mixture to 1180°–1200° C., for about eight hours, all the oxide of sulphur is expelled. This oxide can be used in the manufacture of sulphuric acid. The calcium aluminates formed in the process of roasting, are found to be water soluble and furnish on hydrolysis, pure crystalline alumina.

The results are summarised in the table given below :—

Al_2O_3 in Bauxite = 58·83%. SO_3 in Gypsum = 44·64%.

	Proportion of Bauxite to Gypsum	Temperature	Time of heating in hours	Yield of alumina per cent.		Loss of SO_3 per cent.
				In Acid extract	In Water extract	
1	2 : 3	1080°–1100°C.	8–8½	52·51	3·43	5·01
2	2 : 4	”	”	53·41	19·61	24·78
3	2 : 5	”	”	54·72	30·63	39·87
4	2 : 6	1270°–1280°C.	”	56·63	15·06	44·64
5	2 : 3	1160°–1180°C.	8–8½	56·38	17·36	37·23
6	2 : 4	”	”	57·81	31·38	44·64
7	2 : 5	”	”	58·61	35·43	44·64
8	2 : 3	1230°–1240°C.	8–8½	57·89	28·64	44·64
9	2 : 4	”	”	57·96	36·49	44·64
10	2 : 5	”	”	58·69	35·76	44·64
11	Bauxite alone	1080°–1100°C.	”	1·65	..	..
12	Gypsum alone	1270°–1280°C.	”	..	..	25·63

Of the 58·8 per cent. of alumina present in Bauxite, 35 per cent. can be leached out by cold water alone. The rest of alumina present in the residue, if treated with a very dilute solution of sulphuric acid, produces aluminium sulphate which can be converted into alum. The residue, left after the extraction of calcium aluminate by water and dilute acid, contains mostly Titanium and Iron as oxides. There is a great demand for titanium oxide as a white paint and the recovery of TiO_2 from this waste residue is engaging the attention of the authors at present. Since the results, so far obtained are promising, it is proposed to carry these operations on a semi-commercial scale. Details of experiments will be published elsewhere.

M. B. RANE.
V. S. DUBE.
M. K. RATNAM.

Chemical Laboratories,
Benares Hindu University,
Benares.
April 11, 1936.

The Detection of Adulteration of Butter-Fat (Ghee).

MY attention has been called to a paper on "The detection of adulteration of Butter-fat (Ghee)" by Prof. N. N. Godbole, in the February number of the *Current Science*. I offer the following comments on this paper :—

The author appears to be in search of some simple chemical test or tests giving figures for which limits could be prescribed and from which alone it could be decided whether a sample of ghee is or is not genuine. This is a problem which has been worked on by food chemists all over the world for the past 30 years; no such test has yet been found. Such a test would, of course, enable food laboratories to carry out their work with the assistance of a few semi-qualified chemists trained to carry out one or two simple routine tests. It is perhaps fortunate for qualified chemists that no such test is available.

I do not agree with Prof. Godbole's suggestion that, in the absence of such tests, ghee can easily be adulterated in such a way that the adulteration is not detectable. In my opinion, if a sample of ghee is fully examined by a competent chemist no substantial amount of adulterant will be missed. Prof. Godbole suggests that Bertram, Bos and Verhagen's A and B values, particularly the latter, have a small range and are exceptionally valuable figures. I disagree. The B value gives a measure of the butyric acid in a sample of ghee; the Kirschner value is a measure of the butyric acid in the distillate obtained in determining the Reichert Meissl value. As the Reichert distillate includes, if not all, at any rate a very high proportion of the total butyric acid, the Kirschner and B values must have parallel values. On the other hand, the determination of the B value is a cumbrous and involved piece of work, whereas the Kirschner value is obtained by a few simple manipulations after determining the Reichert value. I would also point out that as the Reichert value includes practically all the butyric acid of a sample, it is impossible that B value (calculated to 5 grams of fat) can exceed it by any considerable amount. (A small excess is possible as, in determining the Reichert value, only 69% is distilled as compared with 80% in determining the B value.) The figures for B value given in Prof. Godbole's book are not, as they stand, comparable with Reichert or Kirschner values, as the B value is a titration figure corresponding to 5·33 grams of butter-fat while the latter is calculated to 5 grams; no explanation is given as to why the figure is not calculated to 5 grams of fat so as to make it comparable.

I have made two determinations of the B value in exact accordance with Prof. Godbole's methods. One was from a sample having a Reichert value of 36·4; this gave a B value (5·33 grams) of 38·8; calculated to 5 grams the figure becomes 36·4. The other determination was on a sample of ghee, prepared from the milk of a buffalo nearing the end of the period of lactation, which was very kindly prepared for me by the Principal, Agricultural College, Coimbatore. This had a Reichert value of 19·7; it gave a B value (5·33 grams) of 22·9 which, calculated to 5 grams, becomes 21·5. Thus the figures obtained were, as one would expect, similar in value to the Reichert values. Prof. Godbole suggests that a figure of about 31 is the minimum (5·33 grams) B value for a genuine sample. This would mean that the minimum figure, calculated to 5 grams, that he would permit would be 29. Such a figure could not be given by any sample of butter-fat having a Reichert value much lower; on the other hand, it is not only common knowledge that genuine samples may give very much lower values, but some Provinces have even adopted such figures as a legal standard. The A and B values are referred to in the article on "Margarine" in the First Supplementary Volume (1934) to Thorpe's *Dictionary of Applied Chemistry* where it is stated that they are of value for the determination of cocoanut oil and butter-fat respectively in Margarine. I suggest that this is the limit of their application and that even for this purpose they show no marked superiority over the Polenske and Kirschner values. Prof. Godbole states that 5% adulteration can be detected by the B value. If the B value of the original butter-fat is known this is of course so, but the proportion of adulteration can be determined with equal accuracy from the Reichert value when the original value is available for purposes of calculation.

In my opinion no Reichert or similar standards should or could reasonably be prescribed in India. Ghee commonly gives a Reichert value up to 35 and higher figures

have been obtained. On the other hand, in rare cases, genuine samples can give figures as low as 15. The Reichert value is easily determined by a chemist of little experience such as could be, and I understand is, employed at little expense by ghee merchants. The imposing of a standard means that merchants will have a strong temptation to reduce their samples, by adulteration, down to a figure near the prescribed limit. In fact, in some large cities, this is being done. In his Report for 1932 the Health Officer, Calcutta, states that following the fixing of standard Reichert values of 30 and 24 for Buffalo and Cow ghee respectively the name "buffalo ghee" has now disappeared from the vocabulary of the ghee dealers. Ghee now conforms to the minimum standard and high class buffalo ghee is made to do so by adulteration with foreign fat.

It seems to me that the only sound lines on which a chemist, examining ghee under a Food Adulteration Act, can proceed is that he should pass samples having a Reichert value so high—say over 27 or 28—that it is extremely unlikely that they are adulterated. On the other hand, samples having a figure lower than this, which may or may not be adulterated, should not be classified by a rule-of-thumb comparison with some other set of "standards" but should be fully investigated.

There are several lines of investigation all of which are commonly used in my laboratory. One of the first tests to be tried is the Phytosterol acetate test. (My method of carrying out this test is described in a note to the *Analyst* for September 1933.) If the melting point of the Sterol acetate is above 115° C., no matter by how small an amount, Phytosterol is unquestionably present and I can say with confidence that an adulterant wholly or partly of vegetable origin is present. Should this test fail the next most important is, I consider, an estimation of the titre value of the fatty acids. Buffalo ghee very seldom has a titre value exceeding 42·5, the normal figure being between 41 and 42; Cow ghee gives a considerably lower figure. When mutton fat, a very common adulterant, is added to ghee the titre value is raised considerably, and it is not easy for an adulterator to disguise this rise except by the addition of vegetable oils, which would be detected by the Phytosterol acetate test. The titre test will also detect the addition of hydrogenated oils (vegetable or whale), which have been hardened to an abnormal degree. If these tests fail an estimation should be made of the percentage of iso-oleic acid in the sample. Hydrogenated oils contain a considerable proportion of this substance.

Carrying out the tests I have described not only enables the chemist to say definitely that the sample is adulterated but further it enables him, to a limited extent, to classify the adulterant. I would however point out that the Phytosterol acetate test and the determination of iso-oleic acid require a high degree of manipulative skill and are unlikely to give results of value unless the work is done by a fully qualified and highly-trained chemist with considerable experience of the highest class of analytical work.

In his paper Prof. Godbole refers to the Reichert value of Dolphin oil. I have had no opportunity of examining this oil, nor does he give any B value for it. If the Reichert value of Dolphin oil is as stated and if, as is at any rate possible, it is due to butyric acid I see no reason to expect that the B value would give better information about this oil than the Reichert value.

Coming now to the colour-fringes observed in the Butyro-Refractometer, Prof. Godbole uses the simple type of instrument intended for use with butter-fat only, and having a fixed dispersion correction. I use the improved type with adjustable dispersion correction (as in the Abbe Refractometer) which can be set so as to give a dark line, free from colour-fringes, with any liquid giving a figure within the limits of the scale. Working with this instrument I find that when set to give a sharp line, free from colour with a butter-fat giving a reading (40° C.) of 40·0 an equally sharp and equally colourless line is given by a mixture of groundnut oil and cocoanut oil in the proportions which give the same refraction. Accordingly, even though there may be some small differences in colour-fringe between abnormal samples of butter-fat and some mixtures having the same refraction it seems to me impossible that this could possibly be used as a general test for adulteration when it is so simple a matter to prepare a mixture, free from butter-fat having not only the same refraction as genuine butter-fat but also the same dispersion—colour-fringes being merely a manifestation of dispersion.

To summarise, in the writer's opinion neither A—B values, refractometer tests, nor, for that matter, any simple test or set

of tests will enable an analyst to pronounce a definite opinion on a sample of ghee having a Reichert value lower than that normally given by high-grade samples. To give an opinion it is necessary to carry out a full analysis including specific tests for likely adulterants.

HERBERT HAWLEY.

King Institute,
Guindy,
April 24, 1936.

Additional Data on the Homology of Stigmas and Awns.

IN two previous papers[1,2] data establishing the homology of stigmas and awns were presented. With the examination of fresh material under study, additional data are becoming available. Three further evidences are adduced in this note.

The normal stigma in sorghum (as in most grasses) has a smooth style with a feathery stigma above it. A normal awn has a smooth column below and a subule above which is barbed in its entire length. In certain African races the stigma instead of being feathery throughout, has a feathery area at its bottom only, the top two-thirds being devoid of feathers (Fig. 1). When types having such basal feathered stigmas are awned, the subule of the awn is barbed at the basal third only leaving the top two-thirds smooth (Fig. 2). There is thus a parallel behaviour between

Fig. 2.
Basal barbed subule of awn.

the stigma and the awn in this rare stigmatic type of sorghum.

Fig. 1.
Basal feathered stigma.

Fig. 3.
Hairy styles.

The second evidence is furnished by *Sorghum papyrascens*, Stapf, the sorghum manifesting many abnormalities.[3] Two selections of this sorghum showed the rare phenomenon of the usually smooth styles turning hairy (Fig. 3). These hairs are unicellular and tend to be disposed more towards the inner angle of the styler arms. The awns in such flowers show barbs towards

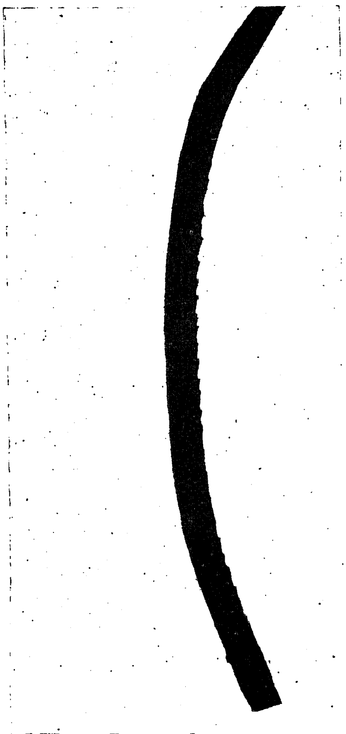

Fig. 4.
Barbed column of awn.

one side of the column (Fig. 4). For an edge view the barbs appear single seriate, but they are really two seriate but close to each other. This concurrent presence of hairs and barbs in the normally smooth styles and columns is very striking.

The third and most graphic proof of this homology is the turning of the subules of some awns into stigmatic structures. This was met with in 7 out of 20 plants in an African race of sorghum. In such plants about one per cent. of the awns developed stigmatic ends. In Fig. 5 is given a photograph of a lemma with an awn whose subule had turned stigmatic. In structure this stigmatic awn was soft, the sclerised area being confined to the base of the column. Stray pollen grains had lodged on the stig-

Fig. 5.
Stigmatic awns.

matic end. The stigmatic area of the stigmatic awn kept the same proportion to the

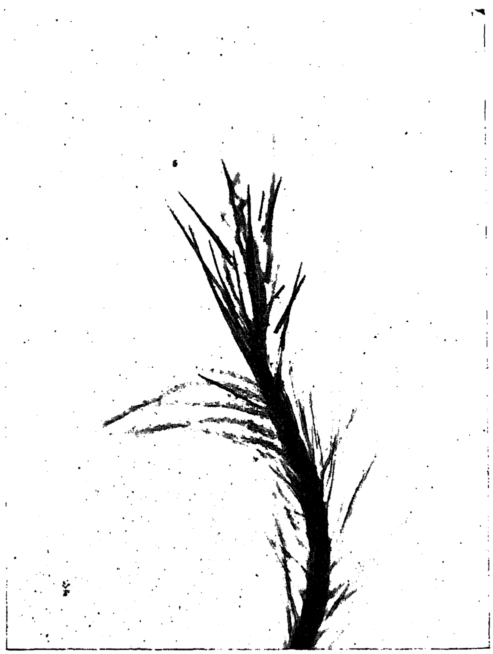

Fig. 6.
Unicellular and multicellular feathers of stigmatic awns.

non-stigmatic area as the barbed subule to the smooth column in the normal awn. All stages in the transition from the unicellular to the multicellular condition were met with (Fig. 6). In the commonest form of the stigmatic awn the top had multicellular feathers and the bottom unicellular hairs. The feathers of the stigmatic awn were as long as the feathers of the normal awn. The most interesting point about this stigmatic awn is the progressive decline in its total length as it tended to be more and more multicellular in condition. In the most stigmatic of this awn the total length got shortened until it approximated the combined length of the normal style and stigma. These observations throw very helpful light on the evolutionary trends from the long linear barbed awn to the specialised shorter feathery stigma.

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April 13, 1936.

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1 *Curr. Sci.*, 1935, **3**, 540–542.
2 *Curr. Sci.*, 1935, **4**, 176–177.
3 *Jour. Indian Bot. Soc.*, 1936, **15**, 139–142.

Awned Palea in Sorghum.

IN the Gramineæ though theoretically both the lemma and the palea can have awns, awned palea are a rarity. In *Amphipogon* an advanced genus of the stipinæ, sub-tribe of the Agrostideæ, Bews[1] notes the occurrence of palea bearing awns. Arber[2] records another instance of awned palea in one of the Bambuseæ—*Schizostachyum chilianthum* Kurz. Awned palea are thus of rare occurrence.

The spikelet in sorghum consists of two outer involucral glumes and two inner floral glumes. It is the fourth and the innermost glume that has a palea and bears a flower. This is the normal condition. When the variety is awned, long or short, it is this fourth glume (lemma) that has the awn. The palea is not ordinarily awned.

A disturbance in this condition arises in the case of spikelets with double grains. In these spikelets the third glume develops a palea and also bears a flower.[3] This extra-fertility within the spikelet is of rare occurrence and brings in its train some unusual phenomena, of which the activation of awns in the palea is one. It has already been recorded that an activation of the awn occurred in the lemma of pedicelled spikelets when they bore grains.[4] In an African race of *Sorghum guineense*, Stapf, segregating for double grained and single grained spikelets, the palea of the fourth glume developed awns, in eight out of the thirty plants. In another family pure for double grains all the plants showed awned palea. The new palea of the third glume in double grained spikelets did not develop the awn. In the segregating family awned palea occurred both in double grained and single grained spikelets. Five earheads were examined and it was noted that one to five per cent. of the spikelets may have their paleas awned. The abnormal double and triple awned look of the spikelets helps to spot out awned palea (Fig. 1). When the palea is awned it may be single awned or double

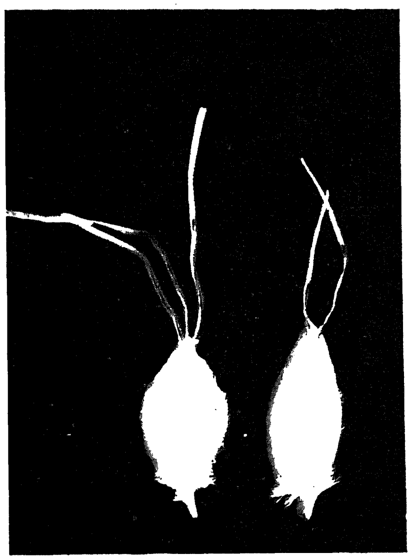

Fig. 1.
Awned spikelets in Sorghum with double and single awned palea.

awned. The single awn is about two-thirds the length of the normal awn though its length fluctuates within wide limits. When the palea has two awns one of these is distinctly smaller than the other (Fig. 2). In the triple awned condition (palea with two awns and lemma with its normal awn) the spikelet shows three awns of decreasing length, the decrease being in an anti-clock-wise direction. The palea with two awns is of more frequent occurrence than the palea with a single awn. When the awns are pronounced there is a tendency for the palea to get bifid. In extreme cases of

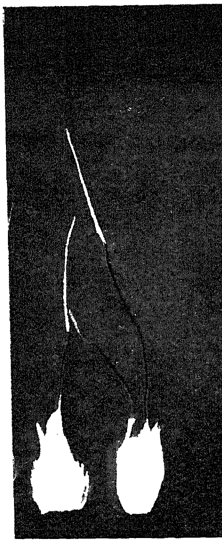

Fig. 2.
Awned palea.

bifiding the palea gets halved, and the two halves occupy a lateral instead of an opposite position with reference to the lemma. An examination of the palea manifesting this awned condition shows that the awns are the prolongations of two nerves of unequal strength in the palea. In non-awned palea these nerves exist in a less marked condition. An examination of a number of paleas shows all intermediate stages between this strong unequal two-nerved condition and the vestiges of the stronger nerve only. This prolongation of the two unequally pronounced nerves of the palea into two unequal awns, provides useful evidence in the interpretation of the palea in Gramineæ.

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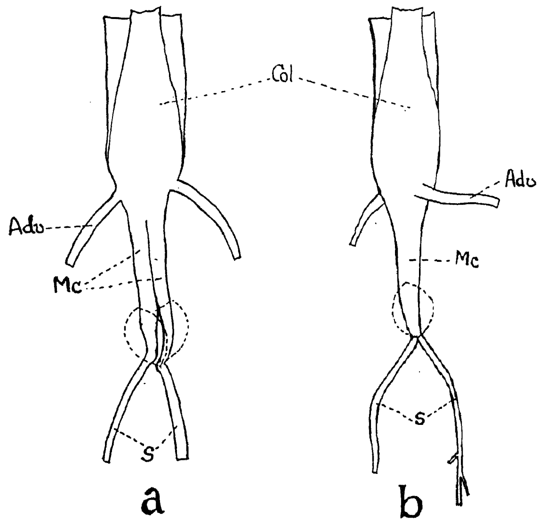
[1] Bews. J. W., *The World Grasses*, 1929, 14 & 120.
[2] Arber, *The Gramineæ*, 1934, 112-13.
[3] *Madras Agr. J.*, 1936, **24**, 15-18.
[4] *Curr. Sci.*, 1935, **3**, 540-542.

False Polyembryony in *Setaria italica*, Beauv.

During the examination of a number of *Setaria* seedlings of K. 193—a loose-panicled, few-tillered variety— 3 instances of two radicles arising from a single seed were noticed. In two seedlings, there were two radicles per seedling, but there was only one



False Polyembryony in *Setaria italica*.
(*a*) Seedling with two mesocotyls and two seminal roots.
(*b*) Seedling with one mesocotyl and two seminal roots.
Col.... Coleoptile. Mc.. Mesocotyl.
Adv.... Adventitious roots. S....Seminal root or Radicle.

plumule (*vide* Illustration *b*). In the third seedling there were two mesocotyls and two radicles attached to a single plumule (*vide* Illustration *a*). In Maize, Kiesselbach (1926)[1] noted seedlings with (1) two plumules each with its own coleoptile and two primary roots enclosed in a single coleorhiza; (2) a single plumule with two primary roots in a single coleorhiza. Rangaswami Ayyangar and Panduranga Rao (1934)[2] recorded in *Paspalum scrobiculatum* L, a case in which there were two plumules each with its own coleoptile but with a single radicle. The first two seedlings described above belong to the second group of Kiesselbach. The occurrence of two mesocotyls, each with its own radicle, attached to a single plumule is not on record. The causes of such false polyembryony are obscure. False polyembryony being a rarity in Gramineæ, this case is interesting.

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[1] *Amer. Jour. Bot.*, 1926, **13**, 33-34.
[2] *Madras Agr. J.*, 1934, **22**, 419.

Research Notes.

Kinetics of Bimolecular Reactions in Solution.

IT is well known that the rates of chemical reactions can all be represented to a close approximation by an expression of the form $PZe^{-E/RT}$, where Z is the collision frequency and P, a factor independent of temperature. The interpretation of P which can have any value between unity and 10^{-8} (as one passes from the normal to the "slow" reactions), has been a matter of great difficulty. The transition state method developed by Eyring and Evans and Polanyi is helpful in interpreting the rates of "slow" reactions, apparently making no arbitrary assumption. This has thrust the classical mechanism (based on the specification of the collision conditions) to the background. In a recent paper, however, Hinshelwood and Winkler (*J. Chem. Soc.*, 1936, 371) have shown that the transition state method does involve certain arbitrary assumptions. Furthermore, they have shown how the whole range of the values of P can be understood, qualitatively at least, in terms of relatively simple classical ideas and conclude that one should seek all help one can by applying both methods, in the elucidation of kinetics of reactions in solution.

K. S. G. D.

Emulsification by Ultrasonic Waves.

A VERY interesting study on emulsification by ultrasonics has been made by Boudy and Solluer (*Trans. Faraday Soc.*, 1936, **32,** 556; 1935, **31,** 835, 843). The first paper deals with the mechanism of emulsification. With water-oil systems, the formation and collapse of cavities (loose spaces) brought about by the influence of ultrasonic waves, result in emulsification. The idea of formation and collapse of cavities is made familiar to the reader with examples like Osborne Reynold's experiment on "the boiling water in an open tube at ordinary temperature", *i.e.*, water passed through a convergent-divergent tube turns opaque at the narrowest constriction of the tube with a loud hissing noise, and the singing of a kettle shortly before the water boils. Cavitation is also accompanied by partial degasing. Cavities collapse as soon as the conditions which have led to their formation cease to exist. In most cases decavitation is due to rising pressure, as in Osborne Reynold's experiment or decreasing temperature as in the singing of the kettle. Pressures of thousands of atmospheres may be developed at the moment when the cavity collapses to a small fraction of its original diameter. The mechanical impact due to decavitation produces heavy erosion. Chemically inert glass is attacked under corresponding conditions. If steam is brought through a nozzle into water-oil interface, it condenses with the well-known rattling noise as in the case of the singing kettle, a highly dispersed emulsion of the oil-water type being formed. This is a case of emulsification by cavitation and decavitation (collapse of steam bubbles). Acoustic waves consisting of periodical compression and expansion are shown to cause cavitation during the expansion phase and expel the dissolved gas in gas-containing liquids. Ultrasonic vibrations also may cause cavitation in view of the fact that liquids of low boiling point distil at room temperature, a gas-containing liquid is degased when radiated by ultrasonics. Liquids radiated in vacuum by ultrasonics only boil. Cavities are only formed but they do not collapse. The presence of a gas is essential for emulsification by ultrasonics. A certain value of external pressure is found to be necessary. Emulsification is much feebler when the liquids are hot. No mechanism other than cavitation and decavitation would account for this fact.

With mercury-water or organic liquids systems, however, gases have only stabilising effect whereas with water-oil systems they are instrumental in the formation of emulsions. In presence of protective agents, the influence of the presence or absence of gas entirely disappears. The mechanism of emulsification with mercury emulsions is different, since emulsification takes place in vacuum, *i.e.*, under conditions where no effective collapse of cavities can occur. Steam causes no emulsion at mercury-water interface. Therefore the mechanism consists in the minute droplets of water being thrown into mercury, in which they unite when thin films of mercury separating them burst with the formation of a drop of mercury emulsion. This last process happens at the interface. This is true with

mercury-organic liquids systems also. The mechanism of the protective action of gases which would hold for both water and organic liquids with mercury is still obscure.

In their third paper Boudy and Solluer have discussed quantitative results, concerning the nature of emulsions produced under different conditions. In pure emulsions the concentration would rapidly reach a limiting value, the rate of emulsification being equal to the rate of coagulation. The rates of formation and coagulation increase with increasing energy. Regarding the degree of dispersion, highly dispersed emulsions are formed when the time of radiation is short and the energy small. A long time of irradiation and high energy favour coarser particles. An emulsifier favours higher degree of dispersion. Metallic emulsions of wood metal, alkali metals and mercury with oils have also been studied.

K. S. RAO.

Effect of Heat on the Nutritive Value of Proteins.

HAYWARD, STEENBOCK AND BOHSTEDT (*J. Nutrition*, 1936, **11**, 219) have found that the low nutritive value of the raw soya-bean proteins, is doubled when they are cooked at 105° and 120° C. for 90 minutes. The poor growth of animals experimented upon with raw proteins was attributable more to some type of deficiency than to a lack of palatability and this suspicion was confirmed by the normal growth which was secured when casein was supplemented to the diet. The increase in the digestibility and the biological value of the soya-bean protein brought about by cooking is possibly due to the heat having rendered some essential protein fraction, ordinarily unavailable in the raw soya-bean, available for absorption and metabolism.

Work of this character is sadly lacking in India and from the point of national efficiency and economy, the proteins of Indian foods should be investigated under culinary conditions to which they are subjected.

M. S.

The Variability in the Yield of Coffee Bushes.

THE extraordinary variation in yield from plant to plant in coffee is brought in a study of the plants belonging to different varieties carried out with the object of isolating the high yielding strains for propagation by Felix N. Natino (*The Phillipine Agriculturist*, **24**, No. 9). The types of coffee studied were liberica, excelsa, robusta, quillou, and canephora. The range of variation was surprisingly high and also differed with the different varieties mentioned. Thus in Excelsa the range was from 10·1 to 9032·5 grms.; in Liberica from 20·1 to 6700·7 grms.; in Robusta from 5·1 to 7360 grms.; in Quillou from 10·1 to 5708 grms; and in Canephora from 9·6 to 2425 grms. of fresh berries per plant. Taking trees which have given a higher yield than the mean yield for its group based on the average for ten years it was found that in Robusta only 33·7 per cent. of the total could be classed as good yielders; percentage ratios for the other varieties were also low: thus it was 30·3 in Excelsa, 36·9 in Quillou, and 29·4 in Canephora and 56·2 in Liberica thus bringing out forcibly what a very large number of plants in a plantation are poor yielders and the need that therefore exists for ensuring greater care in the selection of plants to propagate from.

The Gum Disease of Citrus.

THIS common and destructive disease which is often responsible for the extinction of various kinds of citrous plants all over the world has been the subject of studies reported in the *Phillipine Agriculturist*, **24**, No. 10. The authors state that in the Phillipine islands the causative organism is *Fusarium solani*, which is also the organism causing the disease in the Citrus trees in Egypt. The Phillipine type of gum disease is said to be less destructive than those elsewhere which are put down as caused by *Pythiacystis citrophthora* and *Phytophthora parasitica*. The fusarium was found in everyone of the specimens studied and it was also found to produce the disease in inoculation experiments. Different species of Citrus showed variation in the degree of susceptibility to the disease; and the four main commercial species in the Phillipines, *viz.*, *C. nobilis*, *C. sinensis*, *C. maxima*, and *C. mitis* may, for this purpose, be arranged in the descending order of the degree of susceptibility. The disease was found to be present throughout the year, the effect being more conspicuous in the dry season than in the rainy months. The inoculum for infection in the

field may come from the rotted bark and the sap and gum oozing out of the lesions. The fusarium seems to tide over adverse conditions in the form of spores in the gummed rotted bark and in the form of mycelium in the partially healing lesions. As regards remedies, limited trials showed that the gum disease can be controlled by cutting out all the invaded bark to the healthy wood, disinfecting the wounds with dilute mercuric chloride solution (1 : 1000) and then painting them over with coal tar. The need for better cultivation and for a study of the possibilities of raising resistant stocks are also indicated.

Variola Vaccinia in Milch Cattle.

DETAILS of a generalised outbreak of cow-pox among buffaloes and cattle in Lahore during March, April and May 1934 has been reported by G. K. Sharma (*Imp. Council of Agr. Res. India, Selected Clinical Articles*, Bull. No. 8, 1936). He has shown from figures collected from several localities in the city that mostly milch buffalo-cows were affected although some milch cows were also attacked. 199 cases were noticed among the former as against 33 among the latter. The characteristic symptoms of fever and the appearance of papules on the teats, udder, vulva, etc., which later developed to vesicles, pustules and crusts were noticed. As a sequelæ 15 to 20% of the affected developed mastitis and stenosis of the milk ducts was observed in 50 to 60% of the cases. The infection spread by contact directly and through milkmen.

S. D. A.

The Economic Minerals of the Gangapur State.

IN presenting a paper on the mineral resources of Gangapur State Dr. M. S. Krishnan (*Transactions of the Mining and Geological Institute of India*, **30**, Pt. 2) has shown that the State consists mainly of Dharwar schists with a subordinate development of Gondwana rocks. They are highly folded and metamorphosed and are made up of a series of manganiferous rocks, quartzites, phyllites, dolomitic marbles and mica schists. The occurrence of gold, lead, manganese, various types of ochres, fire clay, sillimanite, mica and coal have been noticed, but importance is attached only to coal, manganese and building materials, like marble, slate, etc., since they alone occur in fairly large quantities.

The Movement of Underground Waters.

IN discussing the movement of underground water Dr. C. S. Fox (*Transactions of the Mining and Geological Institute of India*, **30**, Pt. 2) has shown that the most important factor is the size of the pore space and not the percentage of the pore space volume which controls such underground water supply. This water during its movement underground carries along with it a large quantity of mineral matter in solution and numerous examples of subsidences caused thereby is given in the body of the paper. The scarcity of radium salts in mineral springs is partly due to the rarity of the material and partly to their insolubility. The mud precipitated from such springs are highly radioactive. He has further shown how earthquakes considerably alter the movement of underground water. Particular care should be taken for the disposal of the sewage water since it finds an easy access to the underground water. In all such cases the advice of the Geological Survey is essential for successful operations.

The Evolution and Classification of Ascidians.

THE evolution and classification of ascidians forms a very fascinating chapter in the history of chordate phylogeny. In a recent paper in the *Phil. Trans. Roy. Soc., Lond.* (B, 530, 1936) N. J. Bevill gives us a new classification from what has been accepted till now. Moreover, the development and variability of the heart, pericardium and epicardium throughout the group are also described. A complete account of the anatomy and development of the primitive genus *Ciona* is given. In ontogeny the tadpole larva after metamorphosis gives rise to a post-larval ascidian. This one differs from the adult in many respects, *e.g.*, the post abdomen,—an epidermal stalk into which extend the retractile muscles of the siphons. As the young assumes adult conditions, this shrinks and is only represented as the vessels of the test in the adult. The author points out that from a ciona-like ancestor, ascidians must have evolved in two directions :—one involving the descent of the viscera into the stalk (Aplouso-

branchiata) and the other where the viscera shifts forwards along the branchial wall. After describing the descent and ascent of the viscera, the influence of dwarfing, the Perophoridæ is dealt with. It is noted that the Perophoridæ may represent an evolution from the primitive cionid stalk independently of the two major trends of descending and ascending viscera described. The inter-relationships of the various orders, families, and genera is given in the form of a genealogical tree.

Behaviour of Bacteria in the Trachea of Immunised Animals.

IN a valuable paper appearing in the *Archiv für Hygiene and Bakteriologie* (1935, **114**, 121–136) Krishnamurthy has described the results of his investigations on the behaviour of bacteria in the tracheal epithelium of normal and immunised animals. A number of micro-organisms are phagocyted by the epithelium of the trachea of guinea pigs and are, therefore, non-pathogenic. In the case of a staphylococcal injection of the nose of the mouse, a strong phagocytosis through the leucocytes but not through the epithelial cells was observed. Many micro-organisms, particularly the 'milzbrandbazillen' of maugeri, pass through the tracheal mucus membrane. In the case of the epithelium of the nose of the mouse phagocytosis was not observed in any particular cell. Non-pathogenic staphylococci were fully phagocyted through leucocytes. With pathogenic pneumococci, it was discovered, only once, that the cocci had penetrated into the lymphatic folds, but this did not happen in the case of immunised animals. The organisms remaining on the mucus membrane are phagocyted by leucocytes. This was observed with pneumococci using immunised mice, with weakened 'milzbrandbazillen', and with virulent 'milzbrandbazillen' using immunised animals. The bacilli are killed in most cases through the action of the exudate or leucocytes or both.

Bequest of Pavlov to the Academic Youth.*

WHAT can I wish to the youth of my country who devote themselves to science ?

Firstly, gradualness. About this most important condition of fruitful scientific work I never can speak without emotion. Gradualness, gradualness and gradualness. From the very beginning of your work, school yourselves to severe gradualness in the accumulation of knowledge.

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis. Howsoever this soap-bubble will rejoice your eyes by its play it inevitably will burst and you will have nothing except shame.

School yourselves to demureness and patience. Learn to inure yourselves to drudgery in science. Learn, compare, collect the facts !

Perfect as is the wing of a bird, it never could raise the bird up without resting on air. Facts are the air of a scientist. Without them you never can fly. Without them your "theories" are vain efforts.

But learning, experimenting, observing, try not to stay on the surface of the facts. Do not become the archivists of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.

Secondly, modesty. Never think that you already know all. However highly you are appraised, always have the courage to say of yourself—I am ignorant.

Do not allow haughtiness to take you in possession. Due to that you will be obstinate where it is necessary to agree, you will refuse useful advice and friendly help, you will lose the standard of objectiveness.

Thirdly, passion. Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.—(*Science*, 1936, **83**, 369.)

* Written just before Pavlov's death, at the age of 87 years, on February 27, 1936. Translated from the Russian by Professor P. Kupalov, chief assistant in the Pavlov Institute at Leningrad.

Polymerisation and Condensation.

THE great advance made in recent times in the study of colloids has gathered for us a vast amount of information on the phenomenon of polymerisation. Indeed the recent knowledge had made the word polymerisation of such wide and general application that a strict definition is not easy to give, though many definitions covering more or less of the known cases have been attempted. The number and variety of polymers known up to now are so large, their methods of formation so varied, their properties so widely different and their practical utility so important that it is necessary to take stock of all known facts about them with a view to correlate and systematise the knowledge. It is therefore a very happy idea of the Colloid Committee of the Faraday Society to have organised a general discussion on this subject under the presidency of Prof. Rintoul. Many valuable contributions have been made from all over the world and most of the contributors have personally taken part in the proceedings. The papers together with the connected discussions thereon have been published as a special number of the *Transactions* of the Society* and are grouped under two parts, the first or the general part containing papers mainly of academic or scientific interest dealing with the more fundamental aspects of the phenomenon and the second or the special part containing papers of commercial and technical interest dealing with specific polymers.

While criticising the vagueness in the use of the word polymerisation, W. H. Carothers (p. 39) defines polymerisation as an inter-molecular combination that is functionally capable of proceeding indefinitely (*i.e.*, leading to molecules of infinite size). The chief peculiarity of polymers consists in the fact that they alone in the organic world possess to a marked extent such mechanical properties as toughness, strength, elasticity, hardness, pliability, etc., properties which are vitally essential for the building up of living organisms and the high degree of structural complexity facilitates the variability of living organisms. It is very well known that weight for weight cellulose and silk are stronger than steel and rubber possesses a combined strength and elasticity not even remotely approached by anything in the inorganic world while diamond is the hardest of all known substances. But it must be remembered that polymers though often very large are not of infinite molecular dimensions as it would appear from Carother's definition. As a matter of fact many polymers have well-defined and not very large molecular weights while, as Staudinger has recently shown in some of his papers, even substances possessing apparently micellar structure are really macromolecules of very large but measurable molecular weights. Indeed, Staudinger classifies colloids into three kinds mainly based on their finite (within limits) molecular dimensions as (1) hemicolloids having chain lengths up to 250 Å and a degree of polymerisation between 20 and 100; (2) mesocolloids having chain lengths from 250 to 2500 Å and a degree of polymerisation from 100 to 1,000 and (3) eucolloids with chain lengths above 2,500 Å and degree of polymerisation above 1,000. Viewed however from the point of shape instead of size, Rideal, in his introductory address points out that a different classification into three heads can be made. They are (1) the long chain polymer or the linear macromolecule formed by the reaction between a monomer and the ever-increasing polymer; (2) the ring molecule that could be pictured as having been formed by the two reactive end groups of a long chain molecule linking up to each other; and (3) the three dimensional space molecule formed by cross-linkages between linear polymers.

With such a large variety in the size and shape of polymers one wonders as to what might be the mechanism that leads on to such a diversity of form and size. A large amount of recent work naturally centres round a study of the physical mechanism of polymerisation and as far as possible, a mathematical analysis thereof. For the full course of polymerisation, it is recognised that four different factors are to be considered as in chain reactions and energy corresponding to each factor should be available in the suitable form before the factor can become operative. To begin with, the first factor is that of chain initiation. Energy of a suitable kind and magnitude should be supplied to the monomeric molecules to activate them into combining with each other; in other words, suitable nuclei of chemical activity should be produced. It is known that isoprene and some other substances even when kept in the dark by themselves will slowly polymerise. This would indicate that even in the absence of any definite external source of energy, it might happen that an occasional though rare molecular collision between two monomeric molecules might be so favourable as to put them into the activated state when they will begin polymerising. Such favourable collisions are necessarily few and far between and that is the cause of the very slow velocity of reaction. However, definite, physical and chemical agencies are known to be capable of producing the nuclei. Isoprene and several other unsaturated compounds will polymerise rapidly on exposure to ultraviolet light. A peculiar feature of photo-chemical induction of polymerisation consists in the fact that, while in the majority of cases polymerisation proceeds under the direct influence of the photon, there are some cases like that of chloroprene where the polymerisation once induced by a flash of light continues on with unabated vigour long after the light is withdrawn. Indeed a small particle of such photo-chemically activated chloroprene polymer continues to grow almost indefinitely when placed in liquid chloroprene. Besides light, other physical agencies known to bring about polymerisation are α-particles, temperature and pressure. In an experiment on the polymerisation of ethylene under high pressure, Dr. Fawcett (p. 119) has found that under ordinary or moderate pressures ethylene polymerises to liquids of molecular weights of the order of 100 to 500 while at 170° and a pressure

* "The Phenomena of Polymerisation and Condensation," *Transactions of the Faraday Society*, Jan. 1936. Price 21 *sh.*

of about 1,000 atmos. the polymerisation yields a solid of molecular weight of nearly 4,000.

Since polymerisation is essentially a reaction between molecules of the same kind, any chemical induction of polymerisation should certainly be of a catalytic nature and indeed a large number of polymers are produced catalytically. The polymerisation of isoprene to a rubber-like substance is very greatly accelerated by sodium while formaldehyde and acetaldehyde are catalytically polymerised by small quantities of formic acid. In some cases a combination of physical and chemical agencies produces polymerisation. Thus Melville (p. 258) finds that in the mercury photo-sensitised polymerisation of acetylene, the photo-chemically excited mercury atom energises the acetylene molecule by adding on to it and this energised acetylene molecule adds on other molecules to form the polymer.

Polymerisation being thus started by some agency or other, the next factor to consider will be the mechanism of chain propagation. Energy of course in some form should be supplied to help the reaction to proceed. It is usually considered that a polymer builds on by the addition of an activated monomer to the ever-increasing polymer. Unless suitable additional assumptions are made this conception might lead to molecules of infinite dimensions. One important consideration to be taken account of in polymerisation phenomena is what is known as the steric factor. It is recognised that only particular patches or regions of a growing chain are active in adding on fresh molecules and the magnitudes of these active patches remain constant while the size of the polymer goes on ever increasing. Hence the chances of an activated monomer meeting with the favourable patch of a growing polymer diminish as the polymer increases in size. This might be supposed to set the limit on the size of the polymer. Dr. Finlayson (p. 70) pictures that a growing polymer, due to thermal or other causes, starts a system of natural vibrations which set up the polymer and the surrounding molecules into a proper state of orientation for combination. J. H. de Boer (p. 10) considers that van der Waal's forces acting between neighbouring molecules can produce a suitable orientation for polymer growth. It should, however, be admitted that though a number of pictures are suggested, one cannot pitch upon any one picture as the correct one. Probably the truth lies distributed among them all and it will be necessary to know more before the correct picture can be pieced together.

The third factor to consider in the history of polymerisation has got to do with the phenomenon of chain branching. Something happens to a growing polymer which makes it branch off laterally and link on to neighbouring chains, thus forming a three-dimensional space polymer. A great advance in this field has been the production of intentional branching accomplished by Staudinger[1] by the addition of a very minute quantity of divinyl benzene to styrene which results in the formation of cross-linked polystyrenes. It would appear from such reactions that the divinyl benzene cross-links the straight polystyrene chains. Carothers (p. 39) introduces a conception of functionality in polymerisation to explain such cases. He defines functionality as the number of functional groups present in each monomer. Bifunctional molecules are supposed to produce chain polymers while the extra functional groups in polyfunctional molecules are supposed to give the necessary activity for cross linkages. He has indeed worked out an equation connecting the degree of reaction, the functionality and the degree of polymerisation. The general validity of the equation however depends upon the meaning given to functionality and he is himself aware of the difficulty of exactly determining the functionality of a molecule without first understanding its chemical behaviour. As a matter of fact, acetylene sometimes behaves like a bifunctional and sometimes like a tetra-functional molecule. It is however commonly agreed that in cross-linkages primary valencies are operative in holding together the chains while the binding forces between (and not in) ordinary chain polymers are of the van der Waal type. This explains why ordinary chain polymers easily swell up and disperse in solvents while cross-linked space polymers swell little or not at all.

The last factor to consider in the growth of a polymer is the cause of cessation of growth or the chain terminating factor. The steric factor has already been mentioned as a possible limiting agency but if it is the only factor it would mean that the molecular weight of the polymer should increase as the reaction proceeds but actually it is not the case. Hence other causes have got to be looked for. Rideal (p. 6) suggests a number of possible causes for chain termination. A growing chain may be arrested by a special type of collision with a monomer molecule involving a different energy of activation and different number of square terms to those involved in chain growth. Also it is possible that as the complexity of the polymer goes on increasing, a reverse effect might set in and the final polymer produced might represent the equilibrium between polymerisation and depolymerisation. It may also happen that a substance which acts as a catalyst for chain initiation and chain progress might act as an inhibitor when polymerisation reaches a certain stage.

This brief survey of the mechanism of polymerisation will give us the impression that much of our present knowledge is what may be called speculative and possible rather than definite or probable. Before our knowledge can become more exact a large amount of experimental data on the properties and structures of polymers will be necessary. Already attempts are being made to collect data from various directions and the evidence thus collected from independant sources should be suitably correlated. Based on the previous conception of the structures of polymers it is possible to calculate the tensile strength of polymers. The calculated values, however, are several hundred times larger than the experimental values, a fact which necessitates the conception of faults or holes (*lockerstellen*) in the structure at which rupture takes place long before a chemical bond is ruptured. Further the study of elasticity has led us to consider that elasticity is essentially a

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[1] *Ber.*, 1934, **67**, 1116.

property of very great molecular complexity and that mesacolloidal or better still eucolloidal dimensions are necessary for the production of high elasticity. There is however much difference of opinion as to whether elasticity is the prerogative of long chain polymers only or whether three-dimensional space molecules also can be elastic. Meyer (p. 148) considers, from a study of the elastic properties of sulphur and polyphosphonitrilic chloride, that the polymerisation of these inorganic substances is similar to that of organic substances. A study of viscosity has been very helpful in determining the shape and size of polymers and indeed more than cryoscopic or ebullioscopic methods, viscosimetric methods have been employed by Staudinger in his estimation of the molecular weights of polystyrenes. The method however is limited in its application and it cannot be applied in the case of eucolloids for which Poiseuille's law does not hold. A study of flow double refraction in solutions has led Signer (p. 296) to deduce the size and shape of the polymers while the course and degree of polymerisation have been followed up by Farquharson (p. 219) by studying the magnetic susceptibility of a growing polymer.

By far the most fruitful field of research in the elucidation of the size and shape of polymers is the evidence obtained from X-ray measurements. Katz (p. 77) has studied the X-ray pattern of a very large number of polymers and it is found that in the case of many complex polymers the structure is one of long parallel rod-like chains in which as Staudinger predicted, the same structural unit is repeated indefinitely. Some polymers like rubber, etc., give diffuse rings similar to the corresponding liquid monomer and these undergo marked changes due to tension. The inorganic polymers, sulphur and polyphosphonitrilic chloride also exhibit definite X-ray patterns characteristic of their structure.

Before concluding, a word may not be out of place about the practical utility of polymerisation. Even though scientifically it is in the infant state of growth, from the technical point of view, as a successful commercial operation, polymerisation is a well-developed affair. The very large amount of natural gaseous hydrocarbons obtained in oil fields is now being polymerised by special methods into liquid fuel and thus a new industry has sprung up (Dunstan, p. 227). The production of synthetic rubber-like substances (Patrick, p. 347) by the condensation between metallic-polysulphides and dihalogenated hydrocarbons and ethers has got a large potential field of importance in the rubber industry, since these products while possessing most of the desirable properties of rubber are chemically more stable and resist organic solvents and oxidation better than rubber.

P. S. SRINIVASAN.

The Education of Girls in India.*

THE Royal Society of Arts has rendered a signal service to the cause of education in arranging this survey of the position of girls' education in India by a recognised authority on matters of women's education at this more than usually opportune time. This address gains added force in view of the fact that Lady Hartog was personally concerned with the deliberations of the Education Committee of the Statutory Commission on Indian Reforms. To the Indian public Lady Hartog's review will be of especial interest as this may help to shape the education policy of the Government with regard to girls' education under the New Constitution.

The predominant feature of the Girls' education in India is that the girls are terribly behind their brothers in education. This is generally assumed to be caused either by the prevailing apathy of parents to send girls to schools or the unpopularity of the curricula pursued at the centres of education. The last census has revealed that under 3 per cent. of the women in British India were literate and in the Native States only Cochin showed a female literary percentage of 22. This, according to Lady Hartog, is due to the dominant Christian element in the population of the State.

The importance of the education of women can hardly be overrated. The education of the girl is in short the education of the mother and through her of her children. The Education Committee of the Simon Commission have definitely recommended that "in the interests of the Indian Education as a whole priority should now be given to the claims of girls' education in every scheme of expansion." One of the most distressing facts revealed by the Report was the fact that in spite of the increasing demand for the education of girls and the opening of more schools in every grade the disparity as between boys and girls at schools was increasing. The years following the publication of the Report have witnessed a most astonishing change in the attitude of the public towards girls' education. The hectic rush of girls to schools of all grades has resulted in the unprecedented increase both in the number of schools and the number of pupils admitted. A refreshing feature of the latest Quinquennial Review on Education is that the tide is continuing to rise and every Provincial Report supports this view. In several provinces girls are even attending boys' schools as the number of girls' schools have proved to be inadequate. Co-education in the primary stage is now to a large extent an established practice. Co-education of this type would be above reproach if it were real co-education. But in many provinces it is only a makeshift to avoid the expense of setting up separate girls' schools. Moreover co-education as it is practised in the Indian schools is a one-sided affair. Girls are admitted to the boys' schools as a concession and a convenience. They do not have any real place in the school life. In none of the schools women teachers are provided and there is no special modification in the curricula to suit the especial needs of girls. A somewhat curious practice in some parts has been to allow little boys to attend girls' schools and the Education

* Abstract of a paper read before the Royal Society of Arts (Indian Section) by Lady Hartog.

Commission goes to suggest that it is better to graft a system of co-education on the girls' schools, since women are better teachers for the young than men. It is gratifying to note that at least Bombay has seriously undertaken the pioneer task of providing trained infant class mistresses for its primary schools.

The obvious way to deal with the problem of "wastage," and with the principle of general compulsion would be to compel children who have entered a school to stay on through the primary course and thus provide them with a sporting chance to become literate. This is being tried for both girls and boys in Madras in the areas coming under the Elementary Education Act. The statistics for areas in which compulsory education is in force make melancholy reading, owing to the reluctance of the authorities to use their powers. The same story of the increase in numbers as in the primary schools is to be found in the secondary schools also. In the Punjab and North-West Frontier Provinces Moslem girls have begun to attend schools in increasing numbers. A source of gratification is the fact that though many of the schools are overcrowded, the accommodation is generally good. Most of the high schools are Government institutions and those founded by private benefactions are run with due regard to the comfort of the scholars.

Until recently the curricula of the girls' schools followed too closely the courses of study for boys except perhaps needle-work, which was included in the former. But of late the idea that girls require something different, fitting them better for the task of efficient "house-making", is gaining ground. As a consequence of this, domestic science has come to be regarded as an essential subject for teacher's training, and is rapidly winning a place in the syllabus of examining bodies as a subject for degree courses. Music, handicrafts and drawing are being introduced into secondary schools and greater attention is being paid to the physical education of the pupils. The Girl Guides Movement has now become widespread and has done not a little to make school life healthier and brighter, at the same time infusing the guide spirit of service. The Junior Red Cross has attracted many and in a few provinces inter-school sports are being organised. University education is becoming increasingly popular with many women. The universities have thrown open their doors to women and in many university bodies women sit in conclave with men. As in the primary schools so in all, but a few special centres, women students attend men's colleges.

This inflow of women into the universities opens up new problems. There is a crying need for opening separate institutions for women in the more conservative provinces and in the places where they go to men's colleges there is the urgent necessity for women's hostels, if women are to enjoy the full advantages of college life. The vital factor that governs all schemes for the furtherance of women's education in India is the provision of sufficient funds.

For the efficient working of the institutions a well-trained body of competent teachers is a pre-requisite, who alone can make the institutions true seminaries of learning. The agency behind the teachers to supervise and control and wisely to utilise the resources at their disposal must also be taken into consideration. Even a passing glance at the statistics shows that Madras stands pre-eminent in the field of training her mistresses and her policy is carefully guided by a Central Advisory Board for Women's Education. But as a contrast to this we see Bihar where men and women become teachers who have barely reached the lower primary standard. In Bengal again much money is being wasted on futile efforts, inasmuch as her many thousands of primary schools are left in the hands of untrained men. In the Punjab we have proof of what an enterprising and efficient inspection can do to elevate the standard of teaching. In the past, lack of suitable women teachers has acted as a serious handicap to any scheme for the spread of girls' education. But it is hoped that with the growth of women's education the situation will be eased to a great extent. Another problem demanding an urgent solution is the recalcitrance of trained teachers to do work in isolated rural areas. A beginning has been made in this direction in the Punjab by opening suitable training centres in rural districts. It is suggested that either hostels should be opened in central localities to enable women to do their work in the vicinity, while permanently residing in these hostels; or a husband and wife be induced to take up residence in a village acting as teachers for both boys and girls.

The reconstitution of the Central Advisory Board of Education is perhaps the most important outcome of the recommendation of the Simon Commission, and the inclusion of two lady members in its personnel is clear proof of the growing appreciation on the part of the authorities of the needs of girls' education in India.

In the concluding part of her speech, Lady Hartog pays a glowing tribute to the pioneer work carried on by the several missions, the *Poona Seva Sadan* and to the excellent work of Prof. Karve in connection with his Women's University. The *Lady Irwin College* for Educational Research is another example of the efforts of the All-India Women's Conference to reform the School Curricula for girls.

Finally Lady Hartog puts up a plea and with just cause for the association of women in the administrative services and hopes that the New Constitution will give "them a power which may succeed where reasoned argument has failed".

It is abundantly clear that there has been an awakening in India which has imbued its people with the zeal to stir themselves. Is this as Lady Hartog says "to lose itself as so much enthusiasm has been lost in the past in sterile sands? Or is it to be wisely directed to irrigate fertile soil so that it brings forth in abundance new life, new health, new happiness in the land?" The answer to this rests with the people of India alone.

C. N. RAGHAVENDRA RAU.

The Neophot, a New Microscope for the Examination of Metals and other Opaque Objects.

INCREASING demands for highest quality of raw materials and finished goods have led to extremely stringent and exacting examinations in all branches of industry. This entails the need for most efficient testing instruments.

The Zeiss Works, world-renowned makers of optical instruments, have paid special attention to this need and as a result, have devised an apparatus for microscopical and macroscopical examinations of materials, which satisfies every requirement with regard to performance, versatility and adaptability for different purposes, taking into consideration the necessity for a simple and compact construction so as to give that degree of convenience of operation which is imperative in comprehensive research work.

The NEOPHOT offers the possibility of microscopy and photo-micrography in bright and dark fields as well as in polarised light. The later mode of illumination, in particular, opens to Metallurgists and Research Workers an entirely new sphere. In addition, accessories are available for general survey photography of plane and non-plane objects with vertical and oblique illumination and for macro-photography of large objects in actual size or at small magnifications or reductions. The change from one operation to another can, in all cases, be quickly and conveniently effected, thus allowing the operator to avail himself of the numerous purposes of the instrument without waste of time.

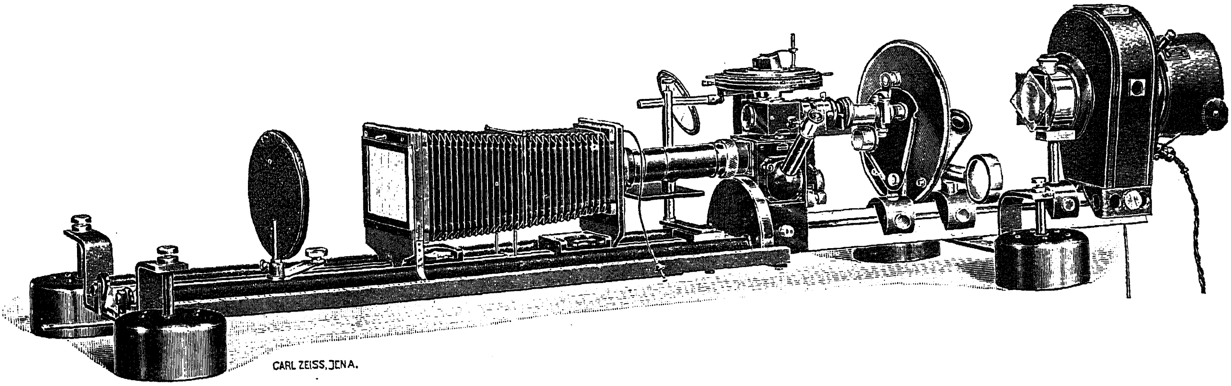

Fig. 1.

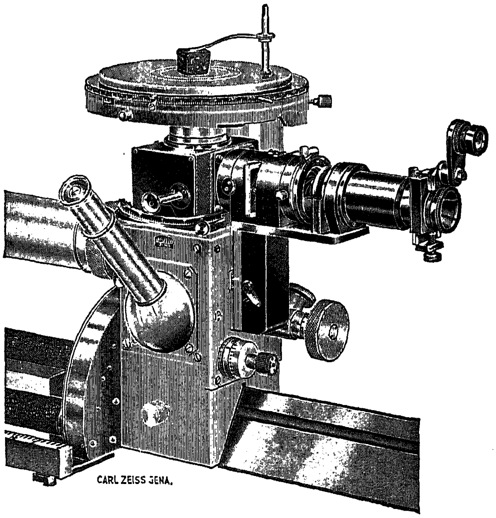

Fig. 2.

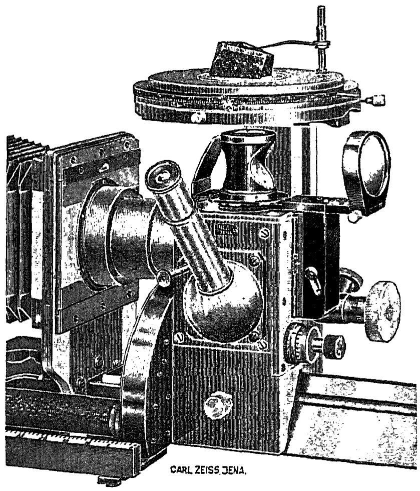

Fig. 3.

A part of the general arrangement of the apparatus is shown in Fig. 1. The Microscope Stand with new combined illuminator for microscopy in bright field, dark field and polarised light, is to be seen from Fig. 2. The Microscope is designed along the lines of the inverted microscope, a successful arrangement ensuring rapid and effortless examinations of sections of opaque objects besides affording independence from the shape and size of the specimen.

The Arc Lamp H provided in the NEOPHOT offers all the advantages of a powerful source of light for photography and observation in dark field and polarised light while the large camera permits the adaptation of the bellows-extension to any magnification and size of object likely to occur in practice.

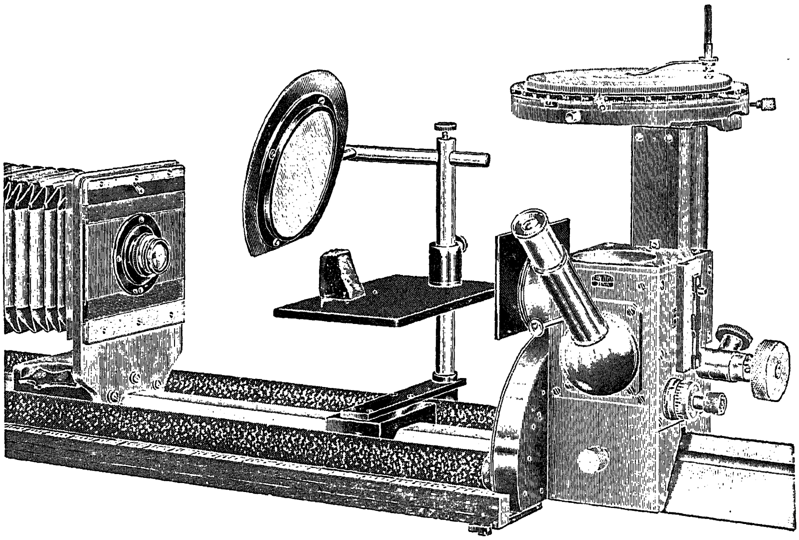

Fig. 4.

From among the many innovations embodied in the NEOPHOT, mention must be made of the remote control of the coarse and fine motions by means of two shafts, one on either side of the optical bench. These always remain in a fixed position and permit of convenient manipulation of the focussing motions from any standpoint beside the camera. A great deal of favourable comment is accorded by users to the anti-vibration mounting and to the swivelling filament lamp for visual examination in bright field which is attached to a screen designed to exclude stray light and saves the need for using the Arc Lamp for visual observation. The anti-vibration mounting functions dependably even in locations subject to severe vibrations.

The equipment for general survey photography with vertical illumination, by means of a plane glass and illuminating lens, can be easily exchanged for a sliding mirror and swivelling ground-glass which provide oblique illumination for the macrophotography of irregularly shaped objects.

Figure 4 shows the equipment for macrophotography of large objects. The object stage and illuminating mirror are simply swung into or out-of position as needed. The microscope stand need not be removed; screwing up the object stage in order to permit the rays to pass from the lamp to the mirror, is all that is required.

As has been experienced so far the NEOPHOT not only satisfies all demands relative to serial metallurgical and other industrial examinations but also represents the ideal and perfect apparatus for research.

Band Spectra and Valency—II.

By R. Samuel, Ph.D. (Goettingen),
Nizam Professor of Physics, Muslim University, Aligarh.

TWO POSSIBLE THEORIES OF VALENCY.

Both the theoretical bonding effects being always present a selection between the two postulates amounts to a choice as to which of these two effects is the more predominating. This involves considerations regarding the dissociation process and the dissociation energy, and therefore the method of molecular orbitals *per se* is not able to decide this question. It can be shown, however, that to reduce the phenomenon of chemical linkage to that of non-premotion is not justified already in the interpretation of the excited terms of H_2^+ all of which are unstable (with the exception of the premoted $3d\sigma\ (2p)$ which has a minimum at large internuclear distance) no matter, whether the electron is on a premoted orbital or on an unpremoted one. This appears significant, because the single bond interpretation of the method of molecular orbitals is a generalisation of the conditions in the molecule H_2^+.

The differences of the two conceptions are rather far reaching. They concern particularly the counting of valencies and the conceptions of chemical union itself. The first one we may discuss by taking up the case of the molecule CO. The electronic configuration of its ground-level contains six p-electrons, on which the linkage rests in any case and which form in the molecule the groups $\pi^4\ (2p)$ and $\sigma^2\ (2p)$. Both orbitals are non-premoted and according to the single electron bond interpretation in which the number of valencies equals the number of non-premoted pairs *minus* that of the premoted ones, those six electrons represent a triple link. According to the pair bond interpretation only those pairs contribute to the linkage, which are composed of electrons of either atom. The C atom possesses only two p-electrons and therefore only two out of the three pairs contribute to the linkage, the two remaining electrons of oxygen do not take part in it. The same configuration $\pi^4\ (2p)\ \sigma^2\ (2p)$ occurs again in N_2 but here also the pair bond interpretation recognises a triple bond, because each of the partners contributes three electrons. This distinction is by

no means superfluous, because only when in cases like CO the second way of counting the valencies (Hund's counting) is valid, the maximal valency of any atom equals the number of its outside electrons and a simple and uniform chemical theory of valency is possible, otherwise this simple relation is lost and we are forced to introduce a large number of hypotheses in order to interpret the experimental results of chemistry.

The second consideration concerns in the main, polyatomic molecules. In the interpretation of the orbital method as a pair bond theory the interaction of the electrons produces electron pairs, which link two atoms, and are localised between them. Because this interaction is missing in the single electron bond interpretation, in polyatomic molecules the electrons are not localised, and do not belong to any two particular nuclei but are related to all nuclei of the molecule. But this view leads automatically to wrong statements on the dissociation processes of the biggest class of molecules. If the electrons are treated as independent, we obtain *e.g.*, in H_2 as dissociation products 50% neutral atoms $H + H$ and 50% ions $H^+ + H^-$. In CH_4 we obtain even 27% neutral atoms only and 73% of the molecules must be assumed to dissociate into various ions. If the electrons would be independent in H_2, then indeed the probability of either electron, to go with one or the other of the nuclei would always be 50%, no matter whether the other electron is already in the vicinity of this nucleus or not. Hence the "overionisation" of the non-localised wavefunctions is a direct expression of the neglection of the interaction inside the electron pairs. The choice of an electron of H_2 to go with a particular nucleus will, however, depend on the choice of the other electron too, when their interaction is introduced and only then the theory gives a correct statement on the process of dissociation or formation. Nevertheless, some authors have preferred the description of the molecule by non-localised wavefunctions, because it appeared, as if the localised functions, as given at first by Hund, represent a poorer mathematical approximation. It could, however, be shown recently, that a different procedure by reducing the ionic terms is always possible, which gives the correct products of dissociation and wavefunctions which are strongly, but not completely, localised between two atoms each. Indeed, some kind of interaction must exist between *all* the electrons of a molecule, or, in other words, any electron will belong to any nucleus with some probability, but the orbital method without considering the actual process of formation, is not able to find out the strength of the different interactions. The result of that localisation which obtains the correct dissociation products, may be described by a strong interaction inside each electron pair and weak interaction from pair to pair. This is the type of strong localisation, which appears to exist in all molecules of the first order.[7] But the type of molecules with non-localised electrons exists too. The benzene ring doubtless possesses non-localised electrons and because they do not belong to particular nuclei, all the structural formulæ proposed by chemistry, are true at the same time. This explains the particular behaviour of cyclic compounds, but because this behaviour is different from that of normal molecules of first order, it indicates also, that the bonds of the latter ones are produced differently, *i.e.*, by electron pairs. A second type of non-localised bonds probably exists among Werner's molecules of second order, *i.e.*, among genuine complex salts[8].

Thus we see that both theories of valency are justified in their own domain. It appears, as if in the discussions of recent years, the distinction between the two possible wavemechanical treatments and the two possible theories of valency has been lost sight of at a too early stage, thus causing some misunderstanding. The two mathematical treatments are certainly both correct, the H.L.S.P. method more adapted for large and the orbital method more for small internuclear distances. The two theories of valency describe each correctly certain different types of molecules. But because both the wavemechanical treatments yield a theory of valency only by the introduction of a postulate, both can be combined with either of the two valency theories. As a matter of fact, all the four possible combinations

	Wavemechanical Method	Valency Theory	Author of this combination	Remarks
1	H. L. S. P.	Electron Pair Bond	Heitler and London, Slater, Pauling.	
2	H. L. S. P.	Single Electron Bond	Pauling and Collabort. (Ring Structures)	Non-Localisation by Hybridisation of different Structures.
3	Orbital	Single Electron Bond	Mulliken (General Theory of Valency). Hund (Molecules with identical nuclei).	Unpremoted Electrons obtain Attractive U : *r* curve. Overionisation.
4	Orbital	Electron Pair Bond	Hund (Molecules made up of different Atoms, Crystals) Present paper. (General Theory of Valency for Non–Aromatic Molecules of first order.)	Electron Pairs obtain attractive U : *r* curve.

[7] H. Lessheim and R. Samuel, *Ref.* (1), page 636 ff.

[8] The non-localisation of the bonds is probably also more or less realised in certain polyatomic hydrides, which approach the view-point of the united atom on account of their small internuclear distances.

can be found in literature and it may not be out of the way, to give an example for each of them in the above table.

SOME ARGUMENTS FOR THE PAIR BOND THEORY.

Because the wavemechanical method becomes a theory of valency only by the introduction of a postulate in whichever way it may be introduced (*e.g.*, by the fixing of the energy relation of the left- and right-hand side of the correlation table or the reduction of the ionic terms, etc.), the decision can be obtained not from the mathematical treatment itself, but only by comparing the consequences with the experimental facts. To our mind the results obtained during the last two or three years clearly indicate, that the description of molecules of the first order (as distinct from organic ring structures or genuine complex salts) by a uniform pair bond theory of valency is a closer approach to reality, even if it involves the sacrifice of the Octet Theory or of co-ordinate linkages in this most important class of molecules. Some of the reasons, which lead us to this point of view, may be summarised as follows :—

(1) The value of the dissociation energy of LiH, the non-existence of LiH^+, Li_2^+ and BeH^{2+} etc. together with the existence of LiH, Li_2, BeH^+ and BeH indicate, that the bonding effect of the single electron on account of the degeneracy of the atomic fields is very weak. It becomes appreciable only in H_2^+, where the fields are rigorously degenerated and the internuclear distance is small.

(2) The excited terms of H_2^+, in which the electron is non-premoted, *i.e.*, bonding, are all repulsive.

(3) The interaction of the electrons is the decisive bonding effect in the H.L.S.P. method. It cannot be neglected in the orbital method because it is just that part of the interaction, which cannot be replaced by a simple screening effect, that the symmetry relations of the total wavefunction depend upon.

(4) If the interaction inside the electron pairs is neglected, the wavefunctions are "over-ionised" and the orbital method gives quite incorrect results as to the products of dissociation. The ionic terms are a direct representation of the independence of the electrons.

(5) Two unpremoted electrons, which form already a closed group in the separated atom, act anti-bonding, and not bonding. This is shown by the band spectra of molecules of the type BeO, BeF, and AlO where the $2s^2$ group acts repulsively.[3,6]

(6) On the other hand, the excitation of a single unpaired electron, like in SiF, NO or BeF, produces an increase of the energy of formation.[2,6] Considerations 5 and 6 appear to be definitely confirmed by the band spectra of a large number of molecules and particularly by that of CdF. Here the first term difference of Cd is much higher than that for a metal of the main group of the periodic table and it is therefore impossible to correlate the ground state of the molecule to the ground state of the Cd atom.[3]

(7) In the single electron bond interpretation the energy of dissociation should go parallel with the polarity of the molecules, because the degeneracy of the atomic fields produces not only the polarity but at the same time the bonding effect. But throughout the periodic table the energy of dissociation goes with the field strength, regardless of the polarity. In the series CO to PbO it decreases with increasing polarity, from CO to CS and CSe it decreases with decreasing polarity.

(8) The amazingly high energy of adiabatic dissociation of CO_2, as revealed by the analysis of the infra red spectrum, indicates, that it is formed by a C atom with 4 equivalent p-electrons.¶

(9) The bond energies of the chlorides and oxychlorides of sulphur as measured by the absorption spectrum of the vapours, indicate, that the S–Cl bond in SCl_2, S_2Cl_2 and $SOCl_2$, the $S=O$ bond in SO, SO_2, $SOCl_2$, the $S=S$ bond in S_2 and S_2Cl_2 possess practically the same strength. This contradicts those formulæ, in which the bond is sometimes supposed to be covalent, sometimes to be co-ordinate and indicates localised pair bonds. According to the absorption spectra and photo-dissociation, the bond energies remain constant and additive so long as inorganic molecules possess p-p bonds only, as in $SOCl_2$ or PCl_3, but change entirely, when the central atom possesses its maximal number of valencies, as in SO_2Cl_2 or PCl_5, indicating the splitting of the s^2 group.[9]

(10) The vibrational analysis of the band spectra of SeO and SeO_2 shows, that the energy of excitation, the symmetric valence vibration of both the unexcited and the excited term of SeO_2 have practically the same value as the excitation energy and the vibrational frequencies of the corresponding terms of SeO. The same obtains from the analysis of the band spectrum of SO_2, whose corresponding constants closely resemble those of SO. This indicates strong localisation of the bonds and is corroborated by infra-red and Raman spectra, because

(11) The internuclear distances and vibrational frequencies of the constituent radicals remain very often unchanged in different polyatomic molecules.[10]

(12) Neither X-ray spectra nor physico-chemical measurements, like parachor, optical activity, etc. are qualified to establish different types of non-electrovalent linkages (semipolar double bond, singlet linkage) in non-aromatic molecules of the first order. Throughout the Periodic Table the maximal valency of all atoms is identical with the number of their outside electrons, and the next lower one in the main groups with that of their outside p-electrons alone. From these and other considerations it appears, as if the experimental facts of chemistry are best represented by a uniform pair bond theory of linkage as far as non-aromatic molecules of first order are concerned.[11]

¶ H. Lessheim and R. Samuel, [*Proc. Phys. Soc.*, (Lond.), 1934, **46**, 523] when suggesting this explanation, had to use estimated values for the anomalous term of C and it is not impossible that these values are slightly too high. But even an error of 3 volts would represent only 10% of the 33 volts energy of adiabatic dissociation of CO_2, which follows from its infra-red spectrum and any other plausible explanation of this high value does not appear to be possible.

[9] R. K. Asundi and R. Samuel, *Proc. Phys. Soc.*, (Lond.), 1936, **48**, 28. Mohd. Jan Khan and R. Samuel, *ibid.* (in press) and forthcoming papers of this laboratory.

[10] R. K. Asundi and R. Samuel, *Proc. Ind. Ac. Sci.*, (Bangalore), 1935, **2**, 30; R. K. Asundi, Mohd. Jan Khan and R. Samuel, *Nature*, Oct. 19, 1935, **136**.

[11] R. F. Hunter and R. Samuel, *J.C.S.*, 1934, 1180; *Rec. Tr. Chim.*, Pays-Bas, 1935, **54**, 114; *Chem. and Ind.*, 1935, **54**, 31, 467, 635.

Science Notes.

A New Variety of Wheat.—Mr. B. S. Kadam, Karjat, writes:

"Wheat is one of the most important staple crops in the Bombay Presidency, occupying an area of over 20 lacs acres per annum, including the Indian States. By far the largest acreage is concentrated in the Deccan, comprising the districts of East and West Khandesh, Nasik, Ahmednagar, Poona, Sholapur and Satara. Over 75 per cent. of the area is under winter (rabi) wheat and is solely occupied by the species, *Triticum durum*, Desf. Locally the wheat is known as *Bansi* or *Pivala*. The Bansi wheat generally contains mixtures of red grains in various proportions, matures unevenly and yields a product poor in colour and lustre. Its yield is low.

The Department of Agriculture in the Bombay Presidency evolved improved strains of winter wheat which are now spreading in the major zones. Recently a new strain, Bansipalli 808, has been released for the Nasik district, which claims nearly 11 per cent. of the total area. The present note briefly describes the new wheat.

Bansipalli 808 was obtained from a cross between the improved Bansi strain, 168, and a synthetic type known as "Kala-Khapli" 568. Unlike the either parent it has white glumes and awns and matures in from 95 to 100 days—about a fortnight earlier than the local wheat.

Bansipalli 808.

It, therefore, does better in lighter soils than the local. The grain of the new wheat is larger in size, more lustrous and attractive in colour than the local. Being biologically pure it produces an even type of grain free from spotting.

The field trials of the new wheat in the district of Nasik have shown its superiority in both yield and quality. The average yield of Bansipalli 808 is 644 lbs. as against 532 lbs. per acre of the local. The better quality of grain fetches a premium of Rs. 2 to 3 per *maund* of 192 lbs. It is estimated that Bansipalli 808 brings to the farmer from Rs. 5 to 7 more per acre.

Bansipalli 808 should be sown slightly more thickly, *i.e.*, about 45 to 50 lbs. per acre, as its grain is large. If sown in the middle of October it escapes rusts and frost, while late sowings are harmful as the dough stage of the crop coincides with low temperatures incident in the middle of January.

The new wheat has spread to the extent of 2,000 acres in the Nasik district. The demand for it is continuously increasing. With a view to accelerate its distribution the Agricultural Department produces pure stock of seed at its experimental farm in the Nasik district. The seed is supplied to the propaganda staff who further multiply the new strain on the private multiplication farms for subsequent distribution to the farmers.

* * *

Pyrophosphatase of Soya Bean (Glycine Hispida).—Mr. K. Venkata Giri, Indian Institute of Science, writes:—

Since the discovery of the presence of pyro-phosphatase in plants, yeast and muscles (Lohmann, *Biochem, Z.*, 1928, **202**, 466) attention has been devoted to the study of the enzyme pyro-phosphatase which is present in several plant and animal tissues. The question whether the pyro-phosphatase is distinct from the phosphatase which hydrolyses glycerophosphatase, hexose diphosphatase and other phosphoric esters has received considerable attention (Kay, *Biochem. J.*, 1928, **22**, 1446; Jacobson, unpublished work, *cf. Biochem. Z.*, 1931, **242**, 393; Takahashi, *J. Biochem. Japan*, 1932, **16**, 447; Uzawa, *J. Biochem. Japan*, 1932, **5**, 19; Bauer, *Naturwissenschaften*, 1935, **51**, 866).

The present note relates to the presence of a pyro-phosphatase which is quite *distinct* from the glycerophosphatase present in the aqueous extracts of germinated Soya bean, *Glycine Hispida* (Black variety). In Table I are given the results obtained by determining the activities of both the phosphatases before and after keeping the dialysed extracts of the germinated seed powder at 45° for about 3 hours at different pH's. The activities were determined at pH 5.2 for both Na β-Glycerophosphate and Na-Pyrophosphate hydrolyses.

TABLE I.

pH	Activity in mg. P after 30 min. hydrolysis at 35°: Naβ-Glycerophosphate	Activity in mg. P after 30 min. hydrolysis at 35°: Na-Pyrophosphate	Ratio: $\frac{\text{Activity of the pyro-phosphatase}}{\text{Activity of the glycero-phosphatase}}$
8.5	0.030	0.222	7.4
5.0	0.250	0.666	2.7
3.5	0.074	0.348	4.7
Control without heating	0.400	0.666	1.6

The results show that the two phosphatases differ in their stability at different pH values, the pyrophosphatase being more stable than the glycerophosphatase. Thus the two phosphatases may be considered to be distinct.

Further work on the complete separation of the two phosphatases, and their rôle and behaviour during the germination of the seed is in progress.

Discoveries at Sakkara.—It is announced that the excavations of the Egyptian Department of Antiquities under the direction of Mr. Walter Emery and Zaki Saad have resulted in very important discoveries at Sakkara (*Nature*, 1936, **137**, 652). The excavations were begun as early as 1931. Present excavations in a series of 42 store chambers in the superstructure of a tomb which previously had escaped notice, has brought to light the complete grave furniture of Hamaka, the Vizier of Pharaoh Den of the first dynasty (*c.* 3000 B.C.). Numerous jars for storing wine with seals giving the names of Hamaka and his king, implements such as wooden sickles and large flint knives, a quiver containing reed arrows with tips of bone or flint and a spear with a head of ivory bearing the name of Pharaoh Zer, are some of the objects found. Other important findings are a large number of disks of stone, bronze or ivory, whose purpose has not been understood. Some of the disks are inlaid with different varieties of stone; the one showing hounds chasing a gazelle is in a style which is said to remind the observer of the products of Minoan art of some fifteen hundred years later. Only part of the chambers has so far been cleared.

* * *

The Ganges Canal Hydro-Electric Grid Scheme.—The upper Ganges Canal which commands 4½ million acres between Hardwar and Aligarh, passes over 13 falls of which eight are economically suitable for electrification. To harness these for energy purposes and complete a grid spreading all over a purely agricultural province, with hardly any concentrated loads, is the aim of the scheme, which promises to be successfully realised in the very near future. The 1934 Enquiry Committee and the 1935 Enquiry Committee unanimously agreed that the scheme is fundamentally sound both from the economic and technical points of view. The system is of potential value to the United Provinces, as a means of expanding agriculture and assisting industry. It has been frequently pointed out that irrigation in Gangetic Valley can no longer be economically developed without some cheap and flexible form of power for pumping water from the deep-set rivers and underground reservoirs. During the years 1931–33, the Irrigation Department of the United Provinces started several tube-wells and showed that extensive irrigation was possible by means of State-owned tube-wells. In 1934, it was decided to extend the vast irrigation project by providing for the construction of some 1,500 wells to command nearly 2 million acres in the western districts of the Province within two years. As a result of this development, it was found necessary to accelerate the construction programmes of the grid scheme with a view to complete it within the financial year 1937–38. The scheme comprising eight generating stations and 1,970 sub-stations spread over a vast area, possesses several distinctive features. It will provide the way for an electrical advance on a larger scale into tracts hitherto beyond the reach of the Ganges Canal falls as a source of power. It will provide for the irrigation of some 2 million acres of land, at present unprotected by irrigation. The combination of steam generation with a hydro-electric system will enable the benefit of cheap electricity to be extended eastwards to millions of agriculturists existing at present on arid tracts with little hope of economic relief.

* * *

Improvement of Cotton in India.—Since the formation of the Indian Central Cotton Committee, the Cotton Industry in India has received an impetus by the increase in the production of suitable varieties combining long staple with a high yield and hardness. In order to ensure the permanency of this improvement, it is essential to assure a sufficient supply of the pure seed. With this object in view, the Indian Central Committee has organised a system of seed distribution in co-operation with Provincial Departments of Agriculture, Co-operative Societies, etc., through a network of seed distribution and extension schemes which are operating in different parts of India.

Scheme	Total quantity of seed distributed in lbs. (1934–35)
Sind (1930)	78,533
Surat (1929)	2,312,818
Hubli (1930)	1,462,861
Khandesh (1931)	1,965,000
Athani (1931)	421,232*
Deccan Canals (Banilla) ..	18,650
Verum Scheme (U. P.) (1930) ..	2,429,616
Raichur-Gulbarga (1930) ..	487,782
Baroda	231,285
Madras (Tiruppur)	1,106,700

* Owing to loss of crops by floods, the returns are much smaller than anticipated.

There has been in India in recent years a steady extension of better varieties of Cotton and higher return to the cultivators.

* * *

Lord Linlithgow and Agricultural Improvement.—A few days after assuming the office of Viceroy and Governor-General of India, H. E. Lord Linlithgow, whose keen interest in effecting agricultural improvement is too well known, purchased two pedigree stud bulls of Hariana breed, one from Karnal and the other from Hissar, which will be made available to the cultivators for breeding purposes. A motor van will be provided to enable their being conveyed to distant villages whenever required. His Excellency is providing a third bull for being presented to the Delhi Pinjrapole for breeding purposes.

In the course of his speech on the occasion of the inspection of the two bulls, the Viceroy laid stress on the fact that the cow and the working bullock bear the entire structure of Indian agriculture. For tilling the soil and carrying the harvest to the market, for the feeding of the expectant mother and for providing nutriment to growing children, the bullock and the cow are essential. For bringing about an effective improvement in agriculture, attention must first be directed towards the improvement of the cattle. His Excellency appealed to the philanthropists to follow his example and come forward with similar offers, in order to bring about a rapid improvement of the cattle throughout the length and breadth of the Country.

Soya Beans.—Mr. C. Jinarâja Dâsa, who has been recently touring in Cochin-China and Java, in a communication addressed to us, mentions that soya bean which is extensively used in the dietary, is considered by the people of the countries to be essential for maintaining their health. Mr. Jinarâja Dâsa writes, "In Java the soya bean sauce, prepared by salting, is considered a prophylactic against malaria. I am credibly informed that every morning all soldiers are obliged to take a tea-spoonful of the sauce."

Soya bean, undoubtedly, enjoys a reputation for its nutritive value; the claim that it is a prophylactic against malaria requires, however, careful scrutiny. Sometime ago, the *Indian Forrester* (1935, **61**, 541, 733, 795) published in its columns correspondence on *beer and malaria*, and it was claimed that beer was a prophylactic against malaria. This was contradicted by some (*cf. Indian Forrester*, 1935, **61**, 665) and supported by others!

* * *

Central Jute Committee.—According to a recent Associated Press message, the Government of India have on hand a proposal to constitute a Central Jute Committee, more or less on the model of the Central Cotton Committee. The Committee will be composed of the Vice-Chairman of the Imperial Council of Agricultural Research, the Agricultural Advisor to the Imperial Council, one representative each of the agricultural departments of the Bengal and Bihar Governments, a representative of the co-operative movement in Bengal, two representatives of the Indian Jute Mills Association, one representative elected by the Bengal National Chamber of Commerce, one representative of the Jute trade nominated by the Bihar Government and one by the Assam Government. The Committee will also consist of eight persons to represent agricultural interests. The appointment of such a committee to conduct research in Jute and watch over the interests of all branches of trade was urged by the Royal Commission on Agriculture under the chairmanship of Lord Linlithgow. The Committee, when appointed, will be under the control of the Government of India.

* * *

Bauxite Prospects in India.—Though bauxite has been known to exist in India in large quantities it has never been exploited adequately for industrial purposes and its only use was found by oil companies for the purification of kerosene and by chemical companies for the preparation of aluminous sulphates on a small scale. Experiments have been in progress for the manufacture of bauxite refractories for furnaces in Bengal and for preparing abrasive products such as grinding wheels. Research in the preparation of calcium aluminate cement has also been successful on a laboratory scale.

As the demand in India for these products is rising, the Indian bauxite will find greater use in the preparaton of refractories, abrasives and cements. At one time it was hoped that calcined bauxite could be exported, but, owing to the high cost of transport, that has not seemed possible. The chief use of bauxite lies in the manufacture of aluminium, but owing to the absence of cryolite nothing on an appreciable scale could be attempted. But cryolite has now been discovered in India and is available in sufficient quantities, and as a result, an Indian aluminium industry is likely to grow in future. Already a beginning has been made by the Kolhapur State where large bauxite deposits exist.—(*Chemical Age*, 1936, **34**, 332.)

* * *

Joint Easter Session, 1936.—Under the auspices of the Association of Economic Biologists, Coimbatore, the Indian Academy of Sciences, the Indian Chemical Society (Madras Branch), the Institute of Chemistry of Great Britain and Ireland (Indian Section), the Society of Biological Chemists, India, and the South Indian Science Association, Bangalore, the Joint Easter Session, 1936 was held in the Central College, Bangalore, from 10th to 14th April 1936, both days inclusive. Dewan Bahadur N. N. Ayyangar, B.A., L.C.E., M.I.E., I.S.E., Chief Engineer, Mysore State, was the President of the Session.

The session commenced with a welcome address by Rajasabhabhushana Sir C. V. Raman, Kt., F.R.S., N.L.

For the purpose of reading original papers the Session was divided into four sections, each section with a separate President, as detailed below:

Section	President	No. of papers communicated
1. Mathematics and Physics	Dr H. Parameswaran, M.A., Ph.D., D.Sc.	6
2. Medicine ..	Dr. B. K. Narayana Rao, B.A., M.B.C.M.	3
3. Chemistry ..	Dr. B. N. Iyengar.	25
4. Biology ..	Dr. M. A. Sampathkumaran.	6

Dr. G. J. Fowler, D.Sc., F.I.C., spoke on the "Recent Advances in Sanitary Science," while Dr. R. Nagendran, M.B.B.S., F.R.C.S., and Dr. B. Venkatasubba Rao, M.B.B.S., M.R.C.P., spoke on the Recent Advances "in Surgery" and "in Medicine" respectively. Rao Bahadur B. Venkatesachar, M.A., F.Inst.P., spoke on the "Recent Advances in Physics."

Mr. N. S. Nagendra Nath, M.Sc., gave a lecture on "Neutrino Theory of Light".

Under the presidentship of Dr. S. Subba Rao, B.A., M.B.C.M., etc., an interesting discussion on "Chemical and Biological Assay of Some Indian Foodstuffs" was held. Miss K. Bhagvat, Mr. M. Sreenivasaya, Mr. Y. V. S. Iyer and Dr. C. N. Acharya were the principal speakers.

There were two public lectures, one by Dr. H. Parameswaran, M.A., Ph.D., D.Sc., F.Inst.P., on "Modern Telescopes" and another by Dr. B. K. Narayana Rao, B.A., M.B.C.M., M.R.C.S., D.P.H., D.O., on "Some Aspects of Defective Vision".

Members of the Session visited the Imperial Institute of Animal Husbandry and Dairying, MacIsaac's Gardens and the Thippagondanahalli Water Works.

* * *

Indian Chemical Society.—At a meeting of the Society held on the 23rd April, the following gentlemen were duly admitted having paid their first subscription:

Mr. Dhirendra Mohon Mukherjee, M.Sc.; Mr. Santiranjan Palit, M.Sc.; Mr. Jagannath Gupta, M.Sc.; and Prof. S. D. Arora, M.Sc., L.T.

The following gentlemen were elected by ballot, Dr. S. Ghosh and Dr. P. K. Bose acting as scrutators;

Dr. Lavji Thoria, Dr. Ing.; Mr. M. U. Parmar, M.Sc.; Mr. A. Jogarao, M.Sc.; Mr. K. Kameswara Sarma, M.Sc.; Mr. Kalipatnapu Kondaiah, M.Sc.; Mr. S. Raju, M.Sc.; Mr. G. R. Phansalkar, M.Sc.; Mr. Sarju Prasad, M.A., M.Sc.; and Dr. T. C. Choudhury, M.A., Ph.D.

Dr. H. K. Sen delivered a lecture on "Place of Technical Research in National Economics".

* * *

Travel in the Stratosphere.—With rapid advances in aviation, the question of travel in the stratosphere is gathering increased interest; it has several advantages; air resistance is very low and visibility is unhindered by cloud, rain or fog; there is no likelihood of air sickness as the air is still and not bumpy.

Prof. Hill (*Jour. Roy. Soc. of Arts*, 1935. **84**, 162) discusses the problem in its two-fold aspect of man and engine under the low pressure and temperature conditions in the stratosphere. For travel in reasonable comfort some 12 km. above the earth, there is no escape from fire-proof, sealed oxygen filled chamber; and the pressure inside has to be maintained at ground atmospheric value on account of the very narrow limitations of the human body in this respect.

In regard to the engine itself, Prof. Hill points out the need for multi-stage superchargers involving additional weight and power. Other problems of the engine are its cooling and lubrication and the choice of suitable fuel.

Considering the time taken for climb and descent, travel in the stratoshpere can only be considered for distances over 1,000 miles; taking the case of the shortest trans-Atlantic crossing (about 1,850 miles), examination of a number of alternatives shows that the advantages appear to lie in flying at a height of some 40,000 feet cruising at 275 miles per hour and carrying four passengers with 800 h.p. More passengers can be carried with increased power.

It is pointed out that speeds equal to or greater than that of sound in air may prove to be difficult on account of energy loss in the shock wave set up by the aeroplane.

R. E.

* * *

Atmospheric Pollution (Twenty-First Report).—His Majesty's Stationery Office, Price 5*s.* net.—Annual Reports are issued on observations made by the bodies co-operating with the Department of Scientific and Industrial Research in the study of the extent, character and variation of atmospheric pollution. Those who have not obtained a copy of the 20th Report may welcome a reminder that it was published last year at the price of 5*s.*, post free 5*s.* 3*d.* The latest report is the 21st which has recently appeared. Special interest attaches to the account it gives, in a "popular" form, of a systematic examination of the data obtained with deposit gauges over a period of 20 years. This analysis will enable plans to be laid for the further investigation of the problem of smoke pollution.

* * *

Prof. Meghnad Saha, F.R.S., of the Allahabad University, was a guest of honour at a party given by the German Academy in Munich, during last month. Prof. Saha enjoys an international reputation for his investigations in Astrophysics. Prof. Sommerfeld, Head of the Department of Theoretical Physics, in the University of Munich, in welcoming Prof. Saha, said that the Professor was a pillar of scientific achievement both in India and in the world of scholars.

Prof. Saha will represent the University of Calcutta at the International Congress of Mathematics which will be held at Oslo from 13th to 18th July 1936.

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Dr. Rudolph Matas, Professor Emeritus of Surgery, Medical School of Tulane University, has been elected President of the International Congress of Surgeons which will be held at Vienna during the summer of 1936.

* * *

Dr. H. K. Sen, Professor of Industrial Chemistry at the Calcutta University, has been appointed Director of the Indian Lac Research Institute, Ranchi, in succession to Mrs. Dorothy Norris.

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It is understood that a Committee of Experts will be appointed by the Government of India to review the working of the Imperial Council of Agricultural Research since its inception.

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It has been decided by the Government of India that in future the Industrial Intelligence and Research Bureau and the Advisory Council for Industrial Intelligence and Research will be known as the "Industrial Research Bureau" and the "Industrial Research Council" respectively.

* * *

Solar Eclipse of June 19th.—A group of American scientists are going to Siberia next June to investigate the nature of the "coronium" in the sun.

On June 19 an eclipse of the sun will be observable in a narrow track across Siberia. During the eclipse, the corona of the sun, a great pearly halo, will be visible. In order to study it a large spectrograph, with a special telescopic extension, has been constructed by Gustave Fassin and Harold W. Straat in the Scientific Bureau of the Bausch & Lomb Optical Co. With this gigantic 700 pound spectrographic camera, Dr. Donald H. Menzel of the Harvard College Observatory, who heads the Siberian expedition hopes to determine whether "coronium" is really a chemical element unknown on earth or whether it is a chemical element already known which exists under extraordinary conditions in the sun.

A record of the spectrum of the corona will be taken throughout the progress of the eclipse, the spectrograph being suspended in a special cradle for this purpose.

Dr. Menzel, and his assistants, Dr. Joseph C. Boyce, of the Massachusetts Institute of Technology and Henry Hemmendinger, of Harvard, hope to discover the important secret which the corona is believed to contain.

* * *

Announcements.

The American Institute of Physics (incorporated), which publishes the following eight Journals in Physics—(1) *Physical Review*, (2) *Physics*, (3) *Review of Modern Physics*, (4) *Journal of the Optical Society of America*, (5) *Review of Scientific Instruments*, (6) *Journal of the Acoustical Society of America*, (7) *Journal of Chemical Physics*

and (8) *The American Physics Teacher*—announces that its address is now 175, Fifth Avenue, New York, U.S.A.

To signalise the fifth year of the co-operative association of the Founder Societies of the American Institute of Physics, joint meetings of the Societies will be held in New York, October 28-31, 1936. In addition to the customary technical sessions, there will be a symposium on Industrial Physics and an Anniversary Dinner.

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The International Health Division of the Rockefeller Foundation wishes to obtain strains of virus from different outbreaks of influenza in order to compare their immunological properties in a study which is now in progress.

* * *

Nature announces that the Second International Congress of Mental Hygiene has been postponed until July 1937 due to the present-day unsatisfactory conditions in the world. It was to have been held in Paris in July 1936 (see *Curr. Sci.*, 1936, **4**, 622).

* * *

The International Commission of Agricultural Industries have decided that the Fifth International Technical and Chemical Congress of Agricultural Industries should meet at Scheveningen (the Hague), Netherlands, from 5 to 10 July, 1937.

* * *

A Congress of the International Federation of Plant Breeders will be held at Wageningen (Netherlands) from 22 to 27 June, 1936. Further information can be obtained from the Secretary Dr. M. J. Sirks, Wageningen.

* * *

At the request of the International Institute of Agriculture at Rome, the Hungarian Government have undertaken to call the Second World Forestry Congress at Budapest (Hungary) from 10 to 14 September, 1936. The proceedings of the Congress will be conducted under the following sections for discussion of subjects: (1) Forestry Statistics and Policy, Forestry Legislation, Institutions of a social order; (2) Forest Management, Forestry instructions and research; (3) Trades in timber and other forest products; (4) Mechanical and chemical science related to wood; (6) Silviculture and the growing of forest plants; (7) Correction of torrent waters, Protection of the soil and standing trees; (8) Rural life and the various types of farming in their relation to forestry, Preservation of natural features, Tourism; and (9) Tropical Forestry.

The headquarters of the Central Organising Committee will be at the Royal Ministry of Agriculture in Hungary, Budapest V, Kossuth Lajos-ter II, and all correspondence should be addressed to them.

At the same time as the Congress, the Permanent International Committee for Charcoal as Carburant (C.I.P.C.C.) will hold its meeting for the year 1936 at Budapest.

* * *

Science announces that the 2nd Preliminary programme of the Fourth International Congress for Experimental Cytology which will meet at Copenhagen from August 10 to 15 has been issued. (See *Curr. Sci.*, 1936, 4, 542). The first five days are devoted to the discussion of the following scientific papers.—Physical chemistry of the soil; Histochemical problems and cell metabolism, Experimental morphology; Electrophysiology of the cell; Experimental cell pathology and Biology of irradiation. The last day will be devoted to excursions and visits to research institutions. Further information can be obtained from Dr. Harold Okkels, Secretary, Institute for Pathological Anatomy, 11, Frederick 51 Vej, Copenhagen, Denmark.

INDUSTRIAL RESEARCH BUREAU.

(1) *Oils and Soap Research Committee.*—The next meeting will be held in Simla on the 1st and 2nd June, 1936. The time and place of the meeting will be intimated later.

The names of official and nominated members who are likely to attend this meeting may please be intimated to the office of the Industrial Research Bureau before the 31st May 1936.

(2) *Second Meeting of the Industrial Research Council.*—The Government of India have decided that the second session of the Industrial Research Council will be held in Calcutta on July 2nd and 3rd, 1936. The hour and place of meeting will be notified later.

A visit to the Government Test House will be arranged for the morning of July 4th, 1936.

* * *

We acknowledge with thanks receipt of the following:—

"Actualités Scientifiques et Industrielles," Nos., 267–269, 272, 275, 276, 278, 279, 280, 298, 309.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Pt. 4.

"Journal of Agricultural Research," Vol. 51, No. 12; Vol. 52, Nos. 1 and 2.

"Journal of Agriculture and Livestock in India," Vol. VI, Pt. II.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4349 to 4352.

"Biochemical Journal," Vol. 30, No. 3.

"Biological Reviews," Vol. 11, No. 2.

"Chemical Age," Vol. XXXIV, Nos. 874-877.

"Journal of Chemical Physics," Vol. 4, No. 4.

"Journal of the Indian Chemical Society," Vol. 13, No. 2.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 4.

"Russian Journal of General Chemistry," Vol. VI, Nos. 1 and 2.

"Journal de Chimie Physique," Vol. 33, Nos. 3 and 4.

"Experiment Station Record," Vol. 74, No. 3.

"Transactions of the Faraday Society," Vol. XXXII, No. 4.

"Indian Forrester," Vol. 62, No. 5.

"Forschungen und Fortschritte," Vol. 12, Nos. 10 to 12.

"Indian Forest Records," Vol. I, No. 2 (Silviculture Series), "A study of the soils in the hill areas of the Kulu forest division, Punjab".

"Transactions of the Mining and Geological Institute of India," Vol. XXX, No. 2.

Government of India Publications:—

"Monthly statistics of production of certain selected industries of India, No. 11 of 1935–36," (Department of Commercial Intelligence and Statistics.)

"Indian Trade Journal," Vol. CXXI, Nos. 1556 to 1559.

Publications of the University of Illinois:—
Vol. 33, No. 24, "Papers presented at the 22nd Annual Conference on Highway Engineering held at the University of Illinois on Feb. 21 and 22, 1935."
Vol. 33, No. 9, "Chemical Engineering Problems."
Vol. 33, No. 32, "Essentials of air conditioning."
Vol. 33, No. 16, "Progress Report of the Investigation of fissures in railroad rails."
"Journal of the Indian Mathematical Society," Vol. II, No. 1.
"The Calcutta Medical Journal," Vol. 30, No. 10.
"Medico-Surgical Suggestions," Vol. 5, No. 4.
"Research and Progress," Vol. II, No. 2.
"Bulletin of the Patna Science College Philosophic Society," No. 6.
"Monthly Bulletin of Agricultural Science and Practice," XXVI, Nos. 7 to12; XXVII, Nos. 1 to 3.
"The Calcutta Review," Vol. 59, No. 2.
"Journal of the American Museum of Natural History," Vol. 37, No. 4.
"Journal of the Bombay Natural History Museum," Vol. 35, Index.
"Nature," Vol. 137, Nos. 3465 to 3468.
"Journal of Nutrition," Vol. 11, No. 3.
"Indian Journal of Physics" Vol. X, Pt. II, and "The Indian Association for the Cultivation of Science," Vol. XIX, Pt. II.
"Indian Physico-Mathematical Journal," Vol. 7, No. 1.
"Canadian Journal of Research," Vol. 14, No. 3.
"Science and Culture," Vol. 1, No. 12.
"Science Progress," Vol. 30, No. 120.
"Scientific American," Vol. 154, No. 5.
"Indian Journal of Veterinary Science and Animal Husbandry," Vol. VI, No. 1.
"Arkiv för Zoologie," Band 27 A, Haften 4, (Nos. 30 to 40).

Catalogues:—

"New Books in General Literature," Spring 1936 (Edward Arnold & Co.).
"Bell's Miscellany," Spring 1936 (G. Bell & Sons, Ltd.).
"Chemie Physik," April 1936 (Verlag Chemie, G. M. B. H.).
"Natural History of Science" April 1936 (Wheldon & Wesley, Ltd.).

Academies and Societies.

The National Academy of Sciences, India:

April 20, 1936. S. N. Banerji: *Surface Tension of Some Colloidal Substances.* R. N. Mittra: *Formation of Periodic Precipitate in the Absence of Foreign Gel.* H. R. Mehra: *On A New Species of the Genus Harmotrema Nicoll, 1914 with a Discussion on the Systematic Position of the Genus.* N. R. Dhar and E. V. Seshacharyulu: *Nitrogen Fixation and Azotobacter Count on the Application of Sugars to the Soil.* N. R. Dhar and S. K. Mukherji: *Molasses as a Manure and as an Agent in the Reclamation of Usar and Alkaline Soil.*—Results obtained from field trials with molasses as a reclaiming agent have been described. Using one ton per acre of alkaline land, the Mysore Agricultural Department could produce 1,200 to 1,800 lbs. of paddy per acre of *Usar* land where crops failed previously. Similar results have been obtained at Cawnpore and at Allahabad.

Indian Academy of Sciences:

April 1936. SECTION A.—T. R. Seshadri and P. Suryaprakasa Rao: *Geometrical Inversion in the Acids derived from the Coumarins. Part II Cis to Trans.*—A rapid and efficient method has been found for preparing coumaric acid and 4-methyl coumaric acid from coumarin and 7-methyl coumarin respectively by treatment with mercuric oxide in the presence of cold alkali. S. Parthasarathy: *Ultrasonic Velocities in Liquid Mixtures.*—The variation of the calculated adiabatic compressibility of the mixtures studied was found to be not always strictly proportional to concentration. K. Sambasiva Rao: *On a Function connected with the Singular Series.* C. S. Venkateswaran: *The Raman Spectrum and Electrolytic Dissociation of Selenic Acid.*—Marked changes in position, intensity, and character of the lines are observed during the transition from the solid to the liquid, and then to aqueous solutions. Max Born and N. S. Nagendra Nath: *The Neutrino Theory of Light.*—There is no reason to introduce the spin of the neutrino, and the difference between the two kinds of neutrinos can be described in the same way as the difference between electrons and positrons in Dirac's theory of holes. M. L. N. Sharma: *On the Error Term in a Certain Sum.* S. Chowla: *Pillai's Exact Formula for the Number* g (n) *in Waring's Problem.* B. Padhy: *Pillai's Exact Formula for the Number* g (n) *in Waring's Problem.* R. K. Asundi and R. Samuel: *On the Band Systems and Structure of SiF.*—A new vibrational analysis of the results reported by Johnson and Jenkins. Gurdas Ram and V. I. Vaidhianathan: *The Design of Falls with Reference to Uplift Pressure.*—The uplift pressures under hydraulic works on porous foundations, such as are built at the falls in canals and rivers, have been determined. A method of obtaining the pressure distribution approximately by the application of theory has also been indicated. B. Sundara Rama Rao: *Studies on the Anisotropy of Optical Polarisation Field in Liquids—Part III.*—In acetic acid the polarisation field becomes more and more anisotropic whereas in nitrobenzene it becomes more and more isotropic with increasing temperatnre. Ch. V. Jogarao: *Variation of Intensity of Scattered Light with Temperature.*—When the aggregate intensity is suitably separated, the density scattering is always found to increase with temperature as it should, whereas the orientation scattering sometimes increases as in benzene, and sometimes decreases as in nitrobenzene, acetic acid and formic acid. M. Ramanadham: *Refractivity and Magnetic Birefringence of Liquid Mixtures.*—

The shapes of the magnetic birefringence curves have been explained quantitatively by taking into consideration the variations of the anisotropic polarisation field coefficients with concentration.

April 1936. SECTION B.—A. SREENIVASAN: *Investigations on the Rôle of Silicon in Plant Nutrition. Part III.—On the Nature of Interaction of Soil or Hydrogels of Iron Oxide or Alumina with Mixtures of Phosphates and Silicates.* A. SREENIVASAN: *Investigations on the Rôle of Silicon in Plant Nutrition. Part IV.—Effect of Silicate Fertilisation on the Growth of the Rice Plant and Yield of Paddy.*—Treatment with sodium silicate increases the yield of grain and straw both under arid and flooded conditions with and without addition of green manure. The response is greater in arid than in flooded series. D. L. SAHASRABUDDHE: *Fixation of Nitrogen by Rice Soils and Rice Plants.*—Field and Laboratory experiments show that rice soils have the power of fixing nitrogen and this fixation is helped by the presence of the growing roots of the rice plant. It has been shown that the rice seed does not carry within it any nitrogen-fixing organisms. T. R. BHASKARAN: *Investigations on the Rôle of Organic Matter in Plant Nutrition. Part XII.—Production of Organic Acids during Decomposition of Cane Molasses in the Swamp Soil.*—It has been shown that the fermentation of lactate in the soil proceeds in accordance with the Fitz equation and the Virtanen theory of fermentation; that of molasses follows a different course. H. CHAUDHURI AND S. S. LOTUS: *Indian Water-Moulds.—II.*—Three moulds have been described, *viz.*, *Achlya prolifera* (Nees) de Bary, *A. klebsiana* var. *indica*, Nov. Var, and *Thraustotheca clavata* (de Bary) Humphrey. G. PALACOIS AND A. BARI: *The Physiology of Indian Nodule Bacteria.*—The physiological reaction of the three types of Indian nodule bacteria (*C. indicus*, *D. biflorus* and *Ps. tetragonolobus*) have been studied and ascertained, as is indicated in the tables. G. PALACOIS AND A. BARI: *A New Micro-Organism associated with the Nodule-Bacteria in* Cajanus indicus.—A new organism (*Bacillus concomitans* nov. sp.) is described, which is found frequently in the nodules formed in *Cajanus indicus*. N. L. SHARMA AND N. C. NANDY: *A Note on the Petrological Classification of the Basic Intrusives of Danta State (N. Gujrat).*—The basic instrusives of Danta State have been classified. The different rock types may also represent the three basic phases of igneous activity in the area during the post-Aravalli period.

Indian Association for the Cultivation of Science:

March 1936.—S. G. KRISHNAMURTY: *The Spectrum of doubly Ionised Antimony.* B. K. SEN: *The Effects of Heat and Ultra-Violet Light on the Rectifying Action of Some Crystals.* H. P. DE: *Production of Positrons from Bismuth.* S. C. SIRKAR: *On the Nature of Inter-Molecular Oscillations in Some Organic Crystals.* JAGANNATH GUPTA: *On the Interpretation of the Raman Spectra of Formic Acid and Metallic Formates.* SANT RAM: *On the Measurement of* e/m *with a Triode Valve.* BIMALENDU SEN-GUPTA AND S. R. KHASTGIR: *Analysis of Signal-Fading Observations.* M. N. SAHA: *The Origin of Mass in Neutrons and Protons.*

Indian Physical Society:

April 9, 1936. SANT RAM: *On the Measurement of* e/m *with a Triode Valve.* S. C. DHAR: *A Study of the Duration of Contact of a Pianoforte String with a Hard Hammer Striking near the End.* S. C. SIRKAR: *On the Intermolecular Vibrations in Some Organic Crystals.* S. C. SIRKAR: *On the Raman Spectra of CS_2, C_6H_6, CH_3Cl and CCl_4 in Different States and at Different Temperatures.* K. C. MAJUMDAR: *Spectrum of Doubly Ionized Zinc*; D. P. RAY CHAUDHURI AND P. N. SEN GUPTA—*Studies on Constant Paramagnetism. Part II*; K. ROY: *Further Measurements of Field Strength of Calcutta Transmitter.* G. N. BHATTACHARYYA: *Viscosity and Its Temperature Variation of Some Indian Vegetable Oils.* S. DATTA: *On the Raman Spectra of Some Simple and Complex Halides in Solution and the Nature of Chemical Binding in them.*

Indian Chemical Society:

February 1936.—B. S. SRIKANTAN: *Behaviour of Gases under the Influence of High Frequency Discharge, Ammonia and Hydrogen.* TEJENDRA NATH GHOSH: *Formation of Heterocyclic Compounds from Thioacetyl-Carbamic Acid Derivatives—Part I.* SISIR KUMAR GUHA: *Dyes Derived from Acenaphthenequinone. Part V.—2-(6-Methyl)-Thionaphthene-acenaphthylene-indigos.* RAM NATH MISRA AND SIKHIBHUSHAN DUTT: *Dyes derived from Acetylene Dicarboxylic Acid.* E. V. MENON AND D. H. PEACOCK: *The Stereochemistry of Trivalent Nitrogen Compounds. Part I.—The Attempted Resolution of Some Substituted Derivatives of Aniline.* JAGARAJ BEHARI LAL: *Constituents of the Seeds of* Blepharis Edulis *Pers., Part I.* S. KRISHNA AND B. S. VARMA: *Active Principles of* Myrsine Africana, *Linn.* (LATE) A. N. MELDRUM AND G. M. VAD: *Constitution of the Reduction Product of Chloral Acetamide.* (LATE) A. N. MELDRUM AND G. M. VAD: *Condensation of Chloral and Bromal with Polyhydric Alcohols.* MATA PRASAD AND JAGDISH SHANKER: *An X-Ray Investigation of the Crystals of Benzoin.* S. M. MEHTA, M. A. PARMAR AND MATA PRASAD: *Viscosity of Thorium Phosphate Gel-forming Mixtures during Gelation.* WALTER JUNG: *Immersion Pyknometer.* PRAFULLA CHANDRA RAY AND NRIPENDRA NATH GHOSH: *Complex Compounds of Iridium, Part IV.* SHRIDHAR SARVOTTAM JOSHI AND S. JAYA RAO: *Studies in the Coagulation of Colloids. Part XI.—Variation of Optical Refractivity during the Coagulation of Colloid Manganese Dioxide and the New Evidence for the Discontinuity of the Change.*

April 23, 1936.—M. GOSWAMI: *Analytical Use of Nessler's Reagent—Part II.—Quantitative Estimation of Monosaccharides and Disaccharides and Estimation of Furfural.* S. G. CHOUDHURY: *Variation of the Cataphoretic Velocity of Colloidal Particles during Aggregation.*

Meteorological Office Colloquium, Poona.

April 7. Mr. Barkat Ali.—"Visual range by day and by night."

April 14. Dr. K. Das.—"Radio-meteorographs."

April 21. Mr. B. N. Sreenivasaiah.—"Wexler's analysis of a warm front type occlusion over the U.S.A. in October 1933; the preparation of 'atmospheric cross-sections' for daily weather work."

April 28. Dr. S. K. Pramanik.—"G. I. Taylor's paper on 'Statistical Theory of Turbulence'."

University and Educational Intelligence.

Aligarh University :

The Court of the University, at a meeting held on the 10th April, unanimously elected Prof. A. B. A. Hamid as Pro-Vice-Chancellor for two years.

Dr. Azmatullah Elahi was appointed permanent Registrar and Prof. A. M. Qureshi was elected to the Executive Council of the University.

Andhra University :

Award of Research Degrees :—

Doctor of Philosophy (Ph.D.) : Mr. T. S. Narayana, M.SC.—(Subject of Thesis :—"The Budde effect in halogens".)

Master of Arts, Honours (M.A. Hons.) : Mr. S. Ganapathi Rao.—(Subject of Thesis :—"Tariff in relation to the sugar industries in India.")

Annamalai University :

New Appointments.—

1. Mahamahopadhyaya Vidyavachaspathi S. Kuppuswami Sastriar, M.A., I.E.S. (Retd.), has been appointed Honorary Professor of Samskrit.
2. Dr. K. Asvat Narayan Rao, D.SC. (Lond.), F.I.C., has been appointed Professor of Chemistry.
3. Mr. R. Ramanujachariar, M.A., has been appointed Professor of Philosophy.

Courses.—The Academic Council has approved the proposal to revise the course of study in Philosophy for the B.A. (Hons.) Degree, substituting a compulsory course of study of one or two Philosophical classics in Tamil or in Samskrit for the existing course comprising a general study of the History of Indian Philosophy. This will make for an intensive study of Indian Philosophy among the other subjects included in the Honours course.

General.—The Senate, at its annual meeting held on the 21st March, has adopted Statutes instituting "Senior research studentships" of to M.Sc. and M.LITT. graduates of this Univers The value of the existing studentships has b raised from Rs. 30 to Rs. 40 per mensem.

The following resolution was passed by t Senate at the same meeting:

"Resolved that the Senate recommends to t Syndicate that steps be taken to pl concrete proposals before the Senate at t next meeting for instituting and conduct a University Training Corps with a view giving the University students milit training."

University of Mysore :

I. Personnel.—

(1) Mr. Y. Appajee, M.B.B.S., was appoin Assistant Professor of Anatomy in t Medical College.

(2) Mr. M. Bhimasena Rao, Assistant Profe of Mathematics, Central College, Ban lore, was permitted to retire from serv from 30th April 1936.

II. Examinations.—

The results of the L. M. P. Examinations h in March 1936 were announced :

They were as follows :

		No. examined	No. passed
I	L. M. P. ..	47	33
II	L. M. P. ..	53	27
III	L. M. P. ..	53	28
IV	L. M. P. ..	57	26

University of the Punjab :

Award of Research degree :—

PH.D.—Mr. Hansraj Gupta, M.A., Govt. Coll Hoshiarpur. (Thesis :—"Contribution Theory of Numbers.")

Mr. Gupta is the first to get a research de in Mathematics from this university.

50th Anniversary of the Discovery of A. C. Transmission.

THE fiftieth anniversary of the discovery by Mr. William Stanley of the Alternating Electric Current Transmission, was celebrated throughout the United States of America on 20th March (*The Christian Science Monitor*, March 20, 1936). It was in 1886 that Mr. Stanley demonstrated in Great Barrington, Mass., a transformer, which made long distance transmission possible. His early difficulties, strangely enough, were intensified by Thomas A. Edison and Sir William Thomson, who considered the Alternating Current as unnecessary and dangerous. With the aid the transformer, Mr. Stanley, transmitted t current from his laboratory to the village wh he successfully put up a number of lights. Follow ing his success at Great Barrington, Mr Geo Westinghouse established 30 A.C. stations in th course of the year. Later, Stanley founded t Stanley Electrical Company with manufactur headquarters at Pittsfield, which was taken ov by the General Electric Company in 19[illegible].

Reviews.

Theorie der Endlichen und Unendlichen Graphen (Kombinatorische Topologie der Streckenkomplexe). Dénes König. Band XVI, Mathematik in Monographien und Lehrbüchern. (Akademische Verlagsgesselschaft, Leipzig, 1936.) Pp. 248. Price 18 M.

From the view-point of Klein's classification of geometries, Topology or Geometry of Position must be considered as the invariant theory of groups of the most general continuous one-to-one transformations. If mathematics is understood in a narrow sense, as the study of certain kinds of numbers, then topology equally with the Theory of Aggregates and Theory of Groups, forms part of the pre-mathematical foundations of mathematics. While the theory of Aggregates has applications to the *analysis* of the continuum-concept, topology has a more direct appeal to the imagination as it deals with continua in the large and concerns itself with the idiosyncrasies of their behaviour and with their classification; the general method of effecting the classification is by the theory of homology groups of Poincare, whose name stands foremost among the founders of topology. Though Topology and the Theory of Aggregates are both closely related to aspects of function theory, they are too abstract and difficult to be included in the college-course of mathematics—particularly as they both bristle with unsolved problems.

For the beginner, it is perhaps the theory of linear graphs which furnishes the best introduction to topology; even though this theory is not representative of the general methods and procedure of the Geometry of Position to the same extent as surface-topology, it is sufficiently indicative of the type of problems, and concepts with which the subject is concerned. After Sainte-Lagüe's *Les Reseaux* published in 1924, the present book appears to be the first systematic treatise devoted to linear graphs. In writing this book the author has aimed not only at an orderly exposition, but also at a comprehensive digest of graph-theory with full bibliographical references; he has also treated or mentioned all the known applications of the theory. The more difficult parts of the theory of graphs, namely the properties of infinite graphs and problems relating to factorisation of graphs. including Petersen's Theorem are well treated, and the book is a worthy addition to the series in which it has been included.

It is not perhaps generally realised that there is a rich variety of recreational and other applications depending on the theory of graphs. The first topological publication was Euler's in 1736; it arose out of the problem of passing through the seven bridges of konigsberg each only once. Euler's Theorem that *all the vertices of a connected linear graph can be described in a closed circuit, if and only if the number of edges abutting on each vertex is even*, disposed of the konigsberg problem as insoluble. Similarly the problem of finding one's way out of a labyrinth or into the centre of a labyrinth is equivalent to the problem of finding a path between two vertices of a graph known to be connected. Kirchhoff's results relating to the distribution of electric current in a network of conductors are closely related to the fundamental theorems of linear graph theory. "Axiomatik" or the study of the logical relations between the propositions constituting any "doctrine" can be brought under the scheme of the linear graph—as also the relations between the operators of any group—in particular, also the unsolved four-colour problem. It is the same with many solitary games—for instance, the game of traversing all the squares of a chessboard with the Knight. Cayley and Sylvester, pioneers of graph theory studied it in connection with the hydrocarbons and other compounds of organic chemistry—the atoms constituting the vertices and the valency-bonds the edges of the associated linear graph. The closing part of the book contains interesting applications of graph theory to determinants, which are due to the author himself.

Except in certain portions relating to infinite graphs, the mathematical knowledge requisite for understanding the book is of a fairly elementary kind. This should make the book accessible to a wider class of readers than those who are interested in graphs only as an introduction to advanced topology.

R. V.

Integralgeometrie. Von W. Bläschke [*Actualités Scientifiques et Industrielles.*] (Hermann & Cie, Paris, 1935). Pp. 22. Price 7 Francs.

In this little tract containing 18 pages of matter, Prof. Bläschke establishes certain

invariant expressions pertaining to what he calls *Integral Geometry*, a subject whose origin is traced to the well-known "Buffon's Needle Problem" in the theory of probabilities.

Consider in Euclidean space E_n a system of r mutually orthogonal unit vectors a^i $(i = 1, 2, \ldots r)$ in a sub-space E_r $(0 \leqslant r < n)$ formed by taking suitable points x^i. Let b^i $(i = 1, 2, \ldots s;\ s = n - r)$ be other orthogonal vectors which with a^i form a normal orthogonal system with determinant equal to $+1$. Consider

$$p^{ik} = + \sum_t \dot{a}_t^i\, b_t^i = - \sum_t a_t^i\, \dot{b}_t^k$$

where the dots denote differentiation. Let

$$\prod_{\substack{i = 1, \cdots r \\ k = 1, \cdots s}} p^{ik} = F_r$$

where in order to render the sign of F_r definite, the factors p^{ik} are supposed to be written in the dictionary order. Let

$$\nu^i = \sum_t b_t^i\, \dot{x}_t$$

and

$$G_r = \prod_{j = 1, \cdots s} \nu^j \cdot F_r.$$

Then G_r is defined as the "density" (*Dichte*) for the space E_r in E_n, and is proved to be invariant for all Euclidean movements in E_n.

Again, let $\prod_{i=1}^{n} \dot{x}_i = G_0$ and $\prod_{i<k} p^{ik} = S$.

Then $T = G_0 S$ is the "Kinematische Mass" of E_n, and is an invariant.

These ideas are also worked out for non-Euclidean Geometry.

Prof. Bläschke closes with a reference to the work of L. A. Santaló which shows that this subject has some useful applications. In E_2, let K_1 and K_2 be two closed convex regions of which K_1 is fixed and K_2 variable. Let $K = K_1 . K_2$ be the common part between K_1 and K_2. Let T be the "Kinematic density" of K_2, f and u the area and perimeter of K, and n the number of intersections of the bounding curves of K_1 and K_2. Then Santaló's results are

$$\int f\, T = 2\pi f_1 f_2$$

$$\int u T = 2\pi\, (f_1 u_2 + f_2 u_1)$$

$$\int n T = 4 u_1 u_2$$

where u_i, f_i refer to the perimeter and area of K_i.

The last of these formulæ leads to an improvement of a well-known inequality known as the isoperimetric property of the circle. For an oval of perimeter u and area f, we have

$$\frac{u^2}{4\pi} - f = f_4 + 2f_6 + 3f_8 + \cdots\cdots$$

where the areas f_i are generated by means of circles of the same perimeter intersecting the oval in exactly i points.

The subject of "Integral Geometry" is further treated in the following papers:

(1) W. Bläschke, *Integralgeometrie* 2, Berichten der rumänischen Math. Gesselschaft, 1935.

(2) O. Varga, *Integralgeometrie* 3, *Math. Zeitschrift*, 1935.

(3) L. A. Santaló, Geometria Integral 4, *Abhandlungen des Math. Seminars, Hamburg*, 11 (1935).

C. N. S.

Astronomy—A Text-Book for University and College Students. By Robert H. Baker, Ph.D. (Macmillan & Co., 2nd Edition, 1935.) Pp. 522. 16s. net.

This second edition of a well-known textbook on Astronomy is a vast improvement on the first edition and includes the most recent developments of the subject. It bears a great resemblance to that well-known classic, Russell-Dugan-Stewart's *Astronomy* being written almost on the same model but in a less comprehensive manner. In some ways it even goes beyond Russell-Dugan-Stewart inasmuch as brief but clear accounts are given of the doctrine of the expanding Universe, the rotation of the galaxy and recent theories of stellar constitution.

The book is profusely illustrated and easily the best text-book of Astronomy in this respect. Second only to the illustrations are the very valuable innumerable tables interspersed throughout the book. The author's presentation of the subject is logical and clear and all through the extremely wide ground covered, it is hard to point out an instance where the author's treatment would tend to suggest that he was not master of the topic he was dealing with. All these go to make this book one of the very best works on Astronomy ever written.

Examined as a text-book, it is really a rich treasure house for picking up questions to be set in an examination paper. It is

equally enchanting as a book to teach from, permitting as it does a lot of scope to the teacher in choosing the topics for instruction.

For its printing and get-up and the excellence of its contents, the price of 16*s.* is really very reasonable. We refuse to find fault with this book.

B. S. M.

Foundations of Physics. By R. B. Lindsay and H. Margenau. (New York: John Wiley & Sons; London: Chapman and Hall, Ltd., 1936.) Pp. 537. Price 22*s.* 6*d.*

Theoretical physics has taken such enormous and rapid strides in recent years that it has not merely enlarged its own sphere considerably but has made severe inroads into other fields of intellectual activity. The application of mathematical rigour to physical problems has yielded such fruitful results that to-day certain mathematical methods have become uniquely appropriate for particular physical theories.

In the wake of such a remarkable progress, there have appeared excellent treatises on various special developments in the realm of physical thought. However, comparatively few books have been published which present to all those interested, a careful analysis and detailed description of the ultimate theories on which the superstructure of modern physics is built. Lindsay and Margenau have done therefore a real service to the student of physical science by the publication of the book under review.

In the first three chapters, the authors present a critical summary of the meaning of a physical theory, the fundamental concepts of space and time in physics and the foundations of mechanics. In Chapter III on the foundations of mechanics, appropriate treatment is accorded to the principles of D'Alembert and of Hamilton. The chapter on probability (one wishes for a more detailed treatment under this head) is bound to serve as a clear introduction to the subject. After presenting a detailed account of the statistical methods of Gibbs and of Darwin and Fowler, the authors examine the concept of continuum in physics and the electromagnetic field theories. The special and general theories of relativity are next treated in fairly simple mathematical language and finally the foundations of quantum mechanics are examined appropriately at considerable length. The chapter on quantum mechanics is of special interest since the development of the subject is extremely logical and well balanced. After setting forth the axiomatic foundation of quantum mechanics, the authors examine at length the celebrated equation of Schrödinger and the formal structure of matrix mechanics. A clear account is given of the theory of electron spin and Pauli's exclusion principle. The statistical mechanics of Darwin and Fowler are reconsidered from the point of view of quantum mechanical axioms and the reader is naturally led to the elucidation of Maxwell-Boltzmann, Fermi-Dirac and Einstein-Bose statistics. Dirac's theory of the electron is next presented and one cannot help agreeing with the authors that the trend of recent discoveries appears to recede from uniformity and simplicity of explanation. We shall rest on the assurance that the list of discoveries is far from complete and when these are made the lengthening chain will close itself into a ring.

The book closes with a short chapter on the problem of causality under which plain heading a general survey is made of the various theories developed in the earlier chapters.

It will be seen from the foregoing survey that the authors have covered a wide range of subjects all of which serve as foundations to modern physics. They have been successful in their aim, namely, to steer a middle course between a dogmatic treatment of selected theories on one side and a cursory presentation of diverse aspects of modern theories without decisive analysis on the other. Although the book is not intended to be a text-book, certain chapters are of special interest to the advanced students of Indian Universities since they give definite and clear pictures of special theories. The authors are to be congratulated on an elegant presentation of the fundamental concepts of modern physical thought and the book is bound to appeal to a wide circle of readers including philosophers and mathematicians as well as physicists.

S. R. R.

Introduction to Atomic Spectra. By H. E. White. "International Scientific Series." (McGraw Hill Publishing Company, Ltd., London, 1935.) Pp. xii + 458. Price 30*s.* net.

This book, by Prof. White, in the well-known "International Scientific Series" of the McGraw Hill Publishing Company, has been written with the following objectives in view: "First, to start as nearly as possible

at the beginning of each subject; second, to develop each new concept so that the student with a working knowledge of elementary physics and elementary calculus should have little difficulty in following; and third, clearly to illustrate each chapter as far as possible with diagrams and photographs of spectra." Each of the twenty-one chapters in the book reveals that the author has eminently succeeded in achieving the above three objects he had in undertaking the work.

The first chapter gives a useful historical introduction leading up to the early Bohr theory of the hydrogen atom which is treated in full in the second chapter. The third chapter deals with Sommerfeld's extension of Bohr's theory to elliptic orbits and the explanation of the fine structure in the lines of hydrogen and helium as a result of the Relativity correction. Chapter IV discusses Schrödinger's wave equation and the new explanation of the atomic hydrogen spectrum. There is in this chapter a beautiful photographic representation of the electron cloud for various states of the hydrogen atom as made from a spinning mechanical model. In the following chapters are treated usual topics that ought to find a place in any modern book on atomic spectra. The last chapter gives a concise account of the very important subject of the breadth of spectral lines, a topic that generally finds hardly any place in the ordinary run of text-books. Throughout, the treatment is characterised by clarity and fullness. The earnest student ought to find no difficulty in mastering the subject with the aid of this book. The tables at the end, giving the relative intensities of lines in a multiplet for various cases, are very useful to the practical spectroscopist.

The publishers must be congratulated on the excellent get-up of the book. We have no hesitation in recommending the book to University Honours students.

B. V.

The Optical Basis of the Theory of Valency. By R. De L. Kronig, Ph.D. (Cambridge University Press, 1935.) Pp. 237. Price 16 *sh.*

The new book of Professor Kronig is a general introduction to the theory of atomic and molecular spectra. It begins with chapters on X-ray and line spectra and then gives a more detailed account of Band and Raman Spectra of diatomic and polyatomic molecules and of optical methods to determine their energies of dissociation. Apparently the book is meant more for the physicist working in other fields, because those details, which are interesting for the specialist, are not dealt with. Thus a very clear and comprehensive description has been given of the conceptions, which form the basis of the theory of valency. In the sections on the vibrations of polyatomic molecules the author has succeeded in giving a particularly clear account of some rather intricate details, and the chapter on pre-dissociation, to which his own original investigations have contributed so much, naturally forms delightful reading.

If we may venture to criticise one point, it would rather be the title of the book. In reality, the author has made very short work of the theory of valency, and has not gone beyond a very brief description of the contents of the main original papers of some of the investigators like Hund, Mulliken, etc. If he has done so because the theory of valency at the present moment is rather an accumulation of hypotheses and the author wanted to remain in the field of proved and acknowledged theories, this is a very reasonable point of view. But then it should have been made clear, that many of the rules mentioned, are assumptions without experimental proof. As an example, we may mention the identification of non-premoted and bonding electrons, based on earlier correlations of molecular and atomic levels, more and more contradicted by recent experimental results, which in reality is introduced into the theory as a hypothesis.* This, however, is a minor point in such a general introduction and this very clearly written book may be highly recommended.

R. SAMUEL.

Physics. By Erich Hausman and Edgar P. Slack. (Chapman & Hall, London, 1936.) Pp. viii + 776. Price 20*sh.*

The number of text-books in "Physics" must be very large. Starting from the old Ganot and Deschanel series, one passes through Glazebrook and the more recent writers like Crowther and Smith. A progressive science like physics must certainly afford ample scope for writers of text-books, but that they should find so much to write about on the same old fundamental laws in

* See article on Band Spectra. By Prof. R. Samuel. (This number—p. 830.)

the form of an elementary text-book is at times somewhat puzzling. Each writer, of course, believes in his method of presenting the subject to the standard aimed. Some succeed, where others fail.

Text-book writers like examiners have, however, a very important responsibility. They guide the progress of the subject in the country where the book is adopted as the text-book. If they strike a mathematical vein the mathematical aspects get emphasised and the young minds pinning their faith on text-books and examinations regard the mathematical as the correct aspect to attend to. On the other hand, if the experimental and applied aspects are emphasised the book almost loses its appeal to the old-fashioned teachers and examiners who regard the mathematical and the mysterious as the correct and becoming style for physics. This may in some measure be due to the difficulty which the old school of physicists find in following much of the new applied and experimental developments in physcis which have a difficult technique of their own. This danger is particularly great in physics which has both these aspects equally important and rarely is one to be found who could do justice to both aspects adequately and equally.

However, it must be granted that it is a great mistake to over-emphasise the mathematical aspect, at any rate, in junior text-books intended for beginners. This is exactly what has happened in the past and in recent years it is so refreshing to come across a different class of books like Saunders: *Survey of Physics* and Davies and Black: *New Practical Physics* which emphasize the experimental and applied aspects. The present book under review by Hausman and Slack is from this point of view a very welcome addition to the group of text-books of physics specially suitable to correct the theoretical tendencies of the Indian youth. Gyroscopic Compasses, the Hydrostatic thrust on a dam, the calculation of the forces on a roof truss and a variety of such interesting applied aspects receive adequate consideration by simple numerical examples and beautiful illustrations. Omissions are not absent. An applied item of great importance like the horizontal pendulum and seismograph finds no mention. However, it must be granted that it is physically impossible to cover all the items without increasing the size of the volume to unwieldy proportions. On the whole it is a very excellent book particularly suitable for adoption in the B.Sc. classes of Indian Universities.

H. PARAMESWARAN.

The Chemistry of Milk. By W. L. Davies. (Chapman & Hall, London, 1936.) Pp. xii + 522. Price 25*s*. net.

The present volume on the chemistry of milk constitutes the tenth of a series of monographs on applied chemistry and is one which will be welcomed not only by students of dairy science but also by dairy technologists, nutrition chemists, physiologists, public analysts and members of the medical profession.

The volume is divided into five parts, each of them being devoted to a consideration of some special aspect of milk chemistry. The variation in the composition of milk in relation to breeds, individuals, age, period of lactation, climate, kind and quality of feed and disease and other abnormal conditions, has been discussed in considerable detail. The data and graphs presented in this connection should prove most useful to public analysts who have the difficult task of fixing legal limits of composition.

Chapter V deals with milk fats, their variation in composition with breed, feed, indoor feeding and spring pasture. Attention is drawn to the variation in percentage of the unsaturated fatty acids, whose indispensability in the nutrition of animals has recently been established. The discussion on the auto-oxidation of butter-fat and the factors which lead to the rancidity of butter and "fishiness" of milk powders which is included in this chapter, will be of great interest to dairy technologists.

The author has drawn attention to the presence of sugars in human milk other than lactose, a fact which will have to be taken into account by those interested in infant nutrition.

The sixth chapter is concerned with proteins and other nitrogenous constituents of milk which also occur in other physiological fluids like blood and urine. It would be interesting to elucidate the interrelationship between the proteins and the residual nitrogen. The author has dealt with the question of the structure and composition of casein as revealed by physical, physico-chemical and immunological reactions. A considerable amount of work on the enzymatic digestion of casein has been

carried out in recent years and a review of this work would form a most useful addition to this interesting and important chapter. Gróh's recent work on the fractionation of casein does not find mention here.

Attention is drawn to the very interesting similarity in composition between caseins and vitellins, pointing to a similarity in the physiological requirements of the young chick and the mammal.

Comparatively little attention has been paid to the study of lactalbumins and lactoglobulins of milks, and these should form a field of future research, particularly those from the human and ass's milk which are rich in their lactalbumin contents.

That milk proteins exhibit a powerful tendency to aggregate under a variety of conditions to which milk is ordinarily subjected, freezing, heating, pasteurising, etc., is a circumstance which requires careful investigation from the point of view of nutrition.

The mineral constituents of milk and their importance from the nutritional and technical points of view are discussed in the ninth chapter. Bunge has shown that there exists in the case of cat, dog and rabbit, an analogy between the fully grown fœtus and the composition of the ash of the maternal milk; the author has however shown that this fact applies only to mammals with a comparatively short pre-natal life, and which have, therefore, to depend on milk for the complete development of their complement of ash. Special emphasis is laid upon the different forms of phosphorus present in milk and how they are affected by variations of season. The chloride and lactose contents of milk have some analytical interest since the lactose-chloride number has been suggested as an index of abnormality in milk.

An entire chapter is devoted to a discussion of the enzymes of milk, which, being a physiological secretion, contains a number of enzymes. Abnormalities due to diseases which afflict the animal are unmistakably reflected in the enzyme content of their milks, the contents of amylase and peroxidase being the two which are most affected. The physiological significance of these enzymes and their rôle in the nutrition of the young, are still matters of controversy and offer useful lines of enquiry.

Colloid and physical chemistry of milk in relation to some of the technological processes in the dairy industry, forms the subject-matter of the third section of the volume. The range of variation of the freezing point of milk is given for a large number of samples from various authorities, data which are of great value to public analysts who have to deal with adulteration of milk.

Dairy technologists will be particularly interested in the fourth part of this volume which deals with the chemistry of milk processing. Of universal interest is the chapter on milk and metals, which gains great importance in view of the recent recognition of the cumulative effect of the metals on the health of human beings.

The last two chapters on the vitamins and the nutritive value of milk, will have a general appeal. The important function of colostrum in the immunisation of the off-spring, the special rôle of lactose in enhancing the assimilation of calcium and phosphorus and securing their retention in the body in higher percentages, the high supplemental value of the milk proteins with regard to the cereal proteins, are a few of the important points to which attention is drawn.

Interesting experiments on the response of school children to milk in their diet are cited. Increased vitality and vigour, superior intelligence and wider scholarship, greater alertness and quicker perception, characterised the group of school children who were given milk. Authorities who are entrusted with the care of the public health of the country will find a considerable amount of valuable information in the later portions of the volume.

KAMALA BHAGVAT.

The Economics of Diet—Address to the British Association, September 1935. By John Boyd Orr.

Food, Health and Income—Report on a Survey of Adequacy of Diet in Relation to Income. By John Boyd Orr. (Macmillan & Co., London, 1936.) Pp. 71. 2*s.* 6*d.*

These two works are a valuable contribution to the science of nutrition in its broader aspects. Sir John Orr compares the food supply of the United Kingdom with the "optimum" nutritive requirements of the population as defined by modern research; he produces evidence to show that about half the population is living on a "sub-optimum" diet and is consequently not reaching the highest possible levels of health and development; finally, he outlines the changes in agricultural policy and production

which would be necessary if the whole population were to consume an "optimum" diet.

Consumption of various foods per head per day was worked out on the basis of agricultural and import statistics, etc. Since 1909 there has been an increase in the national consumption of animal fat, eggs, fruit, and fresh vegetables—a change in the right direction. But only a very rough picture of the dietary habits of a nation can be obtained by dividing total food supply by number of inhabitants. A further necessary step is to discover how food expenditure is directed in different sections of population at various income levels.

In the present enquiry the population was divided into 6 income groups, ranging from 10*s*. to over 45*s*. per head per week. By means of the study of family budgets, and diet surveys, expenditure per head on food in the various groups was assessed; it ranged from 4*s*. to 14*s*. per head per week. At the same time, by similar methods, an estimate of the actual *direction* of food expenditure in each group was made. It was found that the quality of the diet, reckoned in terms of protein, fat, mineral salts and vitamins, was closely dependent on expenditure; consumption of almost all the most valuable "protective" foods, *e.g.*, milk, butter, cheese, meat, fresh eggs, fruit and vegetables, rose with increasing income. The only foodstuffs which are recorded as having been consumed in greater amounts in the poorer groups, are condensed milk and margarine.

The author marshals evidence to show that in the nation as a whole, the level of health and physique declines with decreasing income and decreasingly satisfactory diet. Certain nutritional diseases—*e.g.*, nutritional anæmia—are most common among the poorer classes. Tuberculosis has a similar class incidence. The remarkable manner in which the addition of "extra" milk to the diet of children of the poorer classes accelerates growth, and improves general health, is evidence that ordinary diets of such children are "sub-optimum".

If the diet of the whole population were to be brought up to the level of that of its best fed sections, this would mean a great increase in the consumption of certain foods—notably milk, butter, eggs, fruit and vegetables. The production of greater quantities of such foods—which are mainly perishable foods suitable for home consumption—lies within the scope of agriculture in the United Kingdom itself; further, the development of agriculture in this direction would not necessarily involve reduction in food imports. While the agricultural industry could thus be greatly stimulated by an increased consumption of "protective" foods on the part of the poorer classes, such consumption would, at the same time, raise national health standards.

Studies of this kind provide a scientific basis for enlightened national food policies, which take into consideration both the prosperity of the farmer and the health of the community.

W. R. A.

Letters from India. By Victor Jacquemont. Translated by Catherine Alison Phillips. (Macmillan & Co., Ltd., London, 1936.) Pp. xxxii + 372. Price 21 *sh*.

That the French excel other nations in the field of letter-writing is well-nigh universally recognised. The publication for the second time of the translations of the correspondence of Victor Jacquemont, a century after its first appearance in print, will surely be considered by many people as a literary event of the first order. It would scarcely be an exaggeration to say that no finer letters from India exist. The easy grace of the composition, combined with sparkling wit, keen observation and delicate humour, entitle the book to the highest place among the published correspondence in any language.

Victor Jacquemont was entrusted by the *Jardin des Plantes* with a roving commission to collect rare specimens of plants and animals in India. Jacquemont's original idea was to explore the entire Indus valley between Multan and Kabulistan. This was abandoned after some deliberation and finally he decided to proceed from Pondicherry to Calcutta, making his way to the Sikh territory of the Punjab. He crossed the Deccan plateau by way of the Narbada valley to Bombay. Had Heaven spared him, this unique tramp would have continued further south, but his untimely death in 1832 cut this short.

As a travelling naturalist of the *Jardin des Plantes* and a man of good family and high talents, Jacquemont won an immediate welcome in the best society in India. He was introduced in an informal way to the Governor-General, Lord Bentinck, and his personal charm soon captivated both Lord and Lady Bentinck, whose friendship

stood him in good stead during his travels. The young foreigner, having political ambitions and endowed with acute powers of observation, supplemented his scientific mission by a critical analysis of the East India Company's Government, the social condition of the land, and he has handed down to succeeding generations a singularly vivid picture of India of a hundred years ago, and of its people, both European and Indian, who were carrying on her administration.

To the British and the Indian reader it is not the style alone but the subject-matter also that makes an instant appeal. The letters are full of reflections upon native rule and the problems "of governing semi-civilised and barbarous races" which are of permanent value to those concerned with questions which "arise when western ideas come in contact with eastern ways of life". There are numerous instances where Jacquemont speaks severely of the extravagant ways of early nineteenth century English life in India. Though many of his criticisms are undoubtedly justified, he has not failed to do justice to the benefits which English rule has conferred on India.

Of particular significance is his account of the Punjab and Kashmir under Sikh domination. The lively pen-portraits of the "Lion of the Punjab" and of other native potentates are valuable historical documents. Jacquemont's interpretation of the many problems of Indian administration by Europeans and his comments thereon are equally applicable to problems arising under similar situations even at the present day.

The student of Indian history will find his delineations of the interesting persons he came in contact with, invaluable. Lord William Bentinck, Ranjit Singh, Shah Shuja, Lord Clare and the eccentric William Frazer, all live before us in his letters. To the general reader Jacquemont will appeal most strongly by the wit and pathos of his letters. His estimation of his literary powers though modest, was nevertheless not inconsiderable. It is to be greatly lamented that he did not live to publish the "three or four volumes" he had intended to bring forth.

It is said that Jacquemont was an artist of no mean talent. But whether in the art of drawing or in that of letter-writing, the same simplicity and economy of means characterise his productions. His letters are diversified by a variety of moods, ranging from the low tones and melancholy strain of his early letters to the exuberant imagery with which he presents his adventures in Tibet and Kashmir. Jacquemont's short life of thirty-one years produced far more than his necessarily limited contributions to natural history. As an artist and a letter-writer and as a keen observer of Indian conditions at an interesting epoch his memory deserves to be kept ever-green.

The excellence of this volume is in no small measure due to the perfect rendering into English of the original French by Mrs. Catherine Phillips. The maps and the index appended at the end enhance the usefulness of the book to the serious reader who wishes to form an exact picture of the travels of the author.

To read Victor Jacquemont's letters provides all the elements of liberal education.

C. N. R. RAU.

Intermediate Botany. By L. J. F. Brimble. (Macmillan & Co., Ltd., London, 1936.) Pp. 562. Price 8*s*. 6*d*.

This is an elementary text-book of botany designed to cover the courses of High schools and Intermediate examinations in Science, Arts, Agriculture, Medicine, etc. of the English Universities. The book is naturally more comprehensive and deals with many such aspects of botany which are not generally found in elementary text-books.

There are altogether thirty chapters with practical exercises at the end of each and a selection of important questions in the appendix. A small section on historical survey gives a short account of the development of more important branches of botany and a page devoted to the history of economic botany furnishes the reader with names of various centres of botanical research within the British Empire. The portions on morphology, histology, general biology, fossil plants, diseases of plants (including virus diseases), vitamins, etc., are very nicely dealt with and the treatment accorded to each is quite adequate for a book of this category.

The special feature of the book, however, is the treatment of the ecological, physiological and physico-chemical aspect of plant-life and relatively greater space has been devoted to these subjects. The student will find these portions stimulating.

The author has succeeded in presenting

within a reasonable compass a fairly complete picture of the different aspects of botany. The simple, lucid style, the avoidance of all but the most essential technical terms and the many, well-chosen, useful illustrations, most of which are drawn by the author himself, contribute to make the book both attractive and interesting. Further, the brief presentation of the more recent developments adds greatly to the value of the book.

There are a few minor errors particularly in the taxonomical portion of the book. They are no doubt due to oversight and it is hoped will be corrected in the next edition.

P. 510. Eicher instead of Eichler.

P. 322: Floral formula of pea (*Pisum sativum*) is given as K_5C_5A (10) G (*2*); compare the same given in pages 321 and 512: K (5) C_5 A (9) + 1 *G* 1.

The instruction (p. 321) that "an inferior ovary is represented by a line over the sign for the gynæcium and a superior ovary by a line beneath" is not followed in the floral formula given in the same page; the lines are below the numbers. There is also a lack of uniformity in this respect as is apparent from pp. 321 and 322 and elsewhere.

No mention is made of the importance of the position of the mother axis in the instructions for "representation of floral structure" (p. 320) neither is it shown in the diagrams given in p. 321, although the mother axis is indicated in the same floral diagrams given elsewhere. Due to the absence of the mother axis, the floral diagram of the wall-flower (p. 321) conveys a wrong meaning.

The language of the book in certain places is rather loose and is likely to be confusing to the beginner for whom the book is meant.

P. 510. "All the orders may be subdivided finally into monocotyledons and dicotyledons" is, strictly speaking, incorrect. The term "sub-divided" is hardly applicable in this case.

P. 500. "The classification of Angiosperms naturally is based on the more variable characteristics." The author intends to convey the idea that the classification is based on those organs which show the greatest evolutionary change. That is, of course, shown more profoundly by the floral organs than by the vegetative organs such as roots. But as expressed by the author it is very likely to be misunderstood by the students.

Pp. 500–501. The statements that "the classification of plants to-day follows closely on that made by the great Swedish botanist Carl von Linnæus" and "the classification of Linnæus is still the basis of present-day classification though much modified" will be difficult to justify. Linnæus suggested the sexual system of classification. It was totally artificial, being based on the number or some other characteristic of the stamen. Linnæus himself was alive to this fact and attempted to classify the plants according to their true affinities into a natural system but did not live to complete it. In the evolution of the natural system of classification the contribution of Linnæus is only indirect. As regards the date of the publication of the Linnæan system of classification it was published for the first time in 1735 in his *Systema Naturæ*. In 1753 in his *Species Plantarum* Linnæus described all the species known at the time.

P. 23. Bacteria are regarded as a subgroup of fungi. But the modern tendency is to give bacteria and fungi an equal status.

The book, on the whole, fulfils certain needs of the student and as such is a very welcome addition to its predecessors. It is conceived on a slightly different plan. There is a certain freshness in the treatment of the subject which makes the book rather interesting. The book is easy reading and stimulating and although mainly intended for students, the layman interested in botany will also find it quite enjoyable.

S. D. G.

Damage by Frost at New Forest, Dehra Dun during the Period 1930 to 1934 (Forest Bulletin No. 91). By Bachaspati Nautiyal. (Manager of Publications, Delhi. 1935.) Pp. 18. Price As. 12 or 1*s*.

Frost injury to Forest crop in India is so rare in the greater part of India that Mr. Nautiyal's paper has an element of uniqueness. The incidence of Frost damage is, apparently, so erratic that it is not always possible "even with considerable past experience, to predict with any degree of certainty the locality, frequency and severity of Frost."

Mr. Nautiyal's main conclusion from his experiments is that protection against Frost is better effected by shading the crop with a cover during nights only than by having cover both night *and* day. In the latter

case, there was presumably a great reduction in the soil temperature "as the surface was never warmed up by the sun, whilst evaporation continued its cooling effect increased by the occasional irrigation." A series of soil temperature measurements recorded by Mr. Nautiyal at depths of 3 and 12 inches below the surface gave results in accordance with this conclusion.

The reviewer can confirm this conclusion by his observations on the Beech (*Fagus silvatica*) in central Europe. As a rule, experience with these Forests indicates that the immediate causative factor in Frost damage is not so much the element of temperature as of *dryness.* It is to be hoped that Mr. Nautiyal will continue his researches in this direction also.

The Author says (p. 5) that the "same Centigrade thermometer was used in recording temperatures". Since there was a set of six readings for each measurement, and since, obviously, there must be the lapse of an interval for the thermometer to correctly record the temperatures, the method admits of a small error in that the temperatures are not taken at exactly the same time. This, of course, could easily be avoided by having six calibrated thermometers to simultaneously take the readings. The record of 40° F. (p. 2) is rather discordant in a scientific paper wherein all other temperatures are reckoned on the Centigrade scale.

The Bulletin is illustrated by four plates of telling photographs.

EMMENNAR.

Francis Amory Septennial Prize.

IN compliance with the requirements of a gift under the will of the late Francis Amory of Beverly, Massachusetts, the American Academy of Arts and Sciences announces the offer of a septennial prize for outstanding work with reference to the alleviation or cure of diseases affecting the human genital organs, to be known as the Francis Amory Septennial Prize. The gift provides a fund from which the income may be awarded for conspicuously meritorious contributions to the field of knowledge "during the said septennial period next preceding any award thereof, through experiment, study or otherwise....in the diseases of the human sexual generative organs in general." The prize may be awarded to any individual or individuals for work of 'extraordinary or exceptional merit' in this field.

In case there is work of a quality to warrant it, the first award will be made in 1940. The total amount of the award will exceed ten thousand dollars, and may be given in one or more awards. It rests solely within the discretion of the Academy whether an award shall be made at the end of any given seven-year period and also whether on any occasion the prize shall be awarded to more than a single individual.

While there will be no formal nominations, and no formal essays or treatises will be required, the Committee invites suggestions which should be made to the Amory Fund Committee, c/o the American Academy of Arts and Sciences, 28, Newbury Street, Boston, Massachusetts, U.S.A. (*Research and Progress*, 1936, **2**, 126.)

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Educational Reform.

According to the Press report published recently the Government of India is contemplating the appointment of a special committee to suggest reforms in the present educational syllabuses and methods, as a sequel to the report of the Sapru Unemployment Committee. The special committee is proposed to be assisted in its deliberations by two or more British experts on technological education. In the meantime the Central Government is considering the report of the Sapru Committee with a view to discover the extent and direction of the application of its proposals for relieving unemployment, in the light of the opinions received from the provinces. The main conclusion of the Sapru Committee is that the problem of unemployment will ultimately be solved by the institution of more technical schools, and by the improvement and adaptation of the existing system of education to the needs of a growing community. The Committee has also suggested measures of reform in the conditions of service with reference to wastage and recruitment. The general aspects of unemployment have been discussed by a number of special committees, the legislative bodies and the leaders of public opinion, who have expounded the causes and remedies of such unemployment. The announcement in the Press that a new committee is speedily to be appointed might lead to the impression that Government is not already surfeited with documents, and it is almost certain that this new committee, however much it may be strengthened by the British experts, is not going to be the last. The problem of unemployment is far too complicated in India to invoke the aid of educational reform alone to provide remedies.

Every school girl knows that unemployment results where the output of trained men and women exceeds the power of their absorption in occupations for which they are fitted. The institution of technical schools and colleges is not a remedy, for they are bound to become crowded by young men and women who, irrespective of their tastes and aptitudes, must necessarily flock to them in the hope of finding suitable employment at the end of their training, and unless commerce and industries keep pace with the annual output of a large number of technical graduates and certificate holders, there is bound to be unemployment among

them, unless they have sufficient capital to launch upon independent commercial or industrial enterprises. The prosperity of these private industries, however, depends upon favourable markets for their products, and also upon their survival value in their competition with the large financial syndicates. We fully sympathise with the desire to encourage technical training, though we feel bound to emphasise the possibility that such training of experts is bound to produce unemployment among them far more speedily perhaps than general education has done among the purely academic graduates. The advocacy for the extension of technical schools might temporarily relieve congestion in the universities, provided careers are offered to all who benefit from training in such institutions, and provided also that Government and other employing agents abandon their insistence on the university degree as a passport to service. The growth and popularity of the technical institutions are generally governed by the rapid expansion and development of commerce and industries in the country, which must demand in an increasing measure the services of a large number of highly trained men. They are the necessary ingredients in the normal evolution of the economic life of the country and their significance and value to its prosperity are practically lost when treated as emergency measures. The causes which have led to unemployment in other countries are not the same as in India; in the former, machinery and women have gradually ousted men, and in the latter, an eager contest for Government posts, a scramble for prizes in all the learned professions which only the specially gifted persons can win and finally the great concentration of the rural population in towns must account for the economic disturbance. This unsatisfactory state of affairs is to be accounted for by the fact that the education imparted to young men and women has generally produced a profound aversion for the profession of their fathers and a fatal madness for positions of power and patronage in the Government service. The attraction, therefore, of the universities and colleges to men who may or may not possess the power to profit by their discipline is frequently alleged as the cause of unemployment in India and naturally the remedy is proposed to be sought by introducing reforms in education. But it must be remembered that so long as the employer requires qualification in either reformed or unreformed education such as colleges and schools can impart, for employment, we need entertain no hope of betterment. It seems to us that the cure for unemployment lies neither in the reforms of education, nor in the establishment of technical institutions, but in the replacement of the university degree by Government examinations so designed as to suit the requirements of the different branches of service, the redistribution of population so that the sparsely populated and unexploited areas in India are developed, the encouragement of emigration within the Commonwealth to enterprising Indians by offering them facilities for settling and acquiring property, and Indianisation of all the branches of service including the Railways.

Although the problem of unemployment is not directly connected with the existing system of education, yet it has not kept pace with the spirit of the modern tendencies in public life. The conception of a New World which the Constitutional Reforms will shortly introduce, is stored, with riches waiting for the Minister of Education to be explored, assimilated and turned to national account. Before him lie the greatest possibilities of the future, perhaps the most fascinating prospect of a great creative effort and an endless field of achievement. Education, interpreted in a broader sense than any acknowledged by its professors, is not at present the dominant concern of the State. The dominant interests of the public are the economic and the political, and education revolves as a dark subsidiary planet in a distant orbit round these self-important bodies. But real and important as they are, they have very little claim to dominate the life of the community for ever. It is this subordinate position into which education has been forced, which must account for the retardation of progress in the country. In the coming order of social and political system for whose appearance the new Reforms have raised hopes, education should be an equal partner in a community of interests. As long as education is made to give way to the demands of politics and economics, which we may arrange into the League of Nations, individualism or socialism, so long we shall make no headway, but rather reinstate on another level the social evils we are trying to cure on this. The fortunes of the

community do not depend on the rearrangement of the political and economic puzzle. They lie in another region, the minds and characters of the citizens which are the fundamental assets of the State. The educational reform to which we look forward is the creation for education a position where, though it may not claim to dominate politics and economics, it shall not permit itself to be dominated by them. It should have the rights and privileges of Dominion Status in the Commonwealth of State interests, in order that its genius might develop on its own lines, freed from the tangle of other departments and the electioneering vicissitudes of party politics.

But as things now are, the control of education is tied up to the wheels of the political chariot, and whatever disasters overtake this chariot, they are immediately reflected in a corresponding injury to the interests of education. The more intelligent section of the public has not visualised the anomaly of a Minister of Education, who has set on foot what is practically a life's work, being thrown out of office, because the party to which he belongs has come to grief in the elections on totally different ground, and his successor, not being interested in his ideas, pulling to pieces the far-reaching plans laid by the defunct member. It is this egregiously vicious system of collective responsibility of the cabinet, which has arrested the development of education, by being associated with interests of a lower level of value. Political vicissitudes break its continuities and discredit its significance. The first step in the educational reform, as we conceive it, is to free the management of its affairs from the baleful political exigencies, and education must cease to be a party product.

The second stage in the process of reform is to abolish from the theory and practice of education the pernicious idea that it has a tripartite division, elementary, secondary and higher, arranged in order of importance, and designed for the different classes of people. The growth of the human mind is continuous and, whatever agency is employed to promote its development, it must be a unitary whole. A great deal of intellectual snobbishness has arisen by treating education as distinct compartments, which, on the other hand, must be conceived as the bond of union which embraces the mind in its entirety. The human mind is not conscious of its own divisions corresponding to the three grades, which, however necessary for administrative purposes, represent only a common enterprise. The conception of education as a unitary process of civilising the human mind amounts practically to the elimination of the examination system. We have assigned to examination a value far greater and more important than really belongs to its function and purpose. This hand maiden now dominates and overshadows the entire household of education, which has quietly receded into the background and its restoration to its proper position of the legitimate mistress is a measure of reform which must necessarily follow the change of our conception of its ideals and functions, as the greatest reconciling element in social life. In the mansion of education, there is a single story, which may be many-sided but still single.

The present system of education is not, as is commonly and frequently criticised, rooted in the life of the people. Its purpose is not relevant to their needs. It is the creation of Government to suit the special needs of administration. It supports their interests and embodies their prejudices. It brings a foreign culture imposed upon the genius of the people from above by the ruling people who think that they know what is good for the country. The country suspects the motive behind it all. These criticisms are as familiar to us as the things by which we are surrounded from childhood. The people are undoubtedly keen for education, if it is good for something, but they are naturally indifferent to what if offered to them in the name of education leading their children nowhere. Education is mixed up with a multitude of other extraneous things, which have nothing to do with it, and of which people do not approve,—institutions and interests which in a very subtle but powerful way it bolsters up and perpetuates. They agree with everything we might tell them about the need and urgency of education, but the actual system and the purpose of education now in practice they distrust. This feeling which is undoubtedly widespread explains the prevailing indifference of the working classes to education. The reform of education must attack this indifference: it can do so only by making the schools so efficient and popular that children will cheerfully and of their own accord come to them and will not willingly leave them. It is through

children that education hopes to reach the parents and society, and it must be remembered that every child who leaves the school unwillingly is a missionary for education, and everyone who leaves it in a contrary frame of mind is a dangerous force on the other side.

We cannot enter here into all the general and special aspects of educational reform, but can only indicate its general principles and the future policy of its control and management. If we think of education in all its bearings and its nature, as lifelong, as interpenetrating all occupations, as teaching every man and woman of doing their work in a better and more intelligent way, as co-extensive with the entire field of social activities, then education should be autonomous in its own territory. This reform being effected, all else will follow.

Madras Fisheries Department.

AS in the previous years, the Administration Report of the Madras Fisheries Department for the year 1934–35 marks another year of continued progress in the working of the Department under the able and enlightened guidance of its Director, Dr. B. Sundara Raj. The year was one of prosperity to the fishing industry on both the West and the East Coasts in spite of the fact that sardine, the most important shoaling fish of the Presidency, was absent during the year and the mackerel was only moderately abundant.

For the students of Indian ichthyology, both pure and applied, the Report is a regular mine of information regarding the progress in our knowledge of the bionomics of some of the principal food fishes of India. During the year under report the discovery of the breeding grounds of the oil-sardine (*Sardinella longiceps*) and the direct proof of the establishment of Catla (*Catla catla*) in the Cauvery river are announced, and it is a pleasure to note that the persistent efforts and the continued application on the part of departmental officials have been crowned with success. One can now confidently hope that the utilisation of the knowledge thus gained will lead to a much greater prosperity to the fishing industry of the Province.

It is also a matter for gratification that the spawning season, eggs and early stages of the half-beak (*Hemirhamphus georgii*) have been worked out and it should now be possible to deal more adequately with the important seasonal fishery of this species in the Palk Bay. A great advance has been made in the breeding of *Etroplus* and it has been proved that it can thrive in ponds where the elimination of natural enemies, such as murrel, snakes and frogs, is not practicable. This fact renders the fish very suitable for stocking ponds, etc.

As was to be expected, the adverse effects of the construction of the Mettur Dam are now being gradually felt in the decrease of the fisheries of the Cauvery below the dam. Unfortunately throughout India no attempt is made to reconcile the needs of the fisheries and of the irrigation projects; the latter invariably lead to the deterioration of the former, resulting in the undermining of a valuable source of food supply.

According to the Director, "The most noteworthy result of technological research is the production for the first time of sardine oil with a vitamin A potency equal to one-fourth that of cod liver oil and the discovery of four other Indian sea fish which yield oils with a high vitamin A content. The remarkable fact has also been ascertained that South Indian shark liver oil is more than 4·2 times as potent in vitamin A as cod liver oil." These researches indicate that a very valuable source of vitamin A will soon be brought within the reach of the poor people leading ultimately to a great improvement in their health.

Besides the fisheries (*sensu stricto*), the Department achieved considerable success in the rearing of Pearl oysters and the possibilities of the production of culture pearls in India on a commercial scale can now be visualised. It is, however, regretted that two and a half years of cultural experiments in the Pulicat edible oyster beds had to be terminated abruptly owing to a disastrous drought during the year under report. All the same, these experiments have furnished precise data concerning the zone at which maximum spatfall occurs and the reason for such occurrence. The Chank market showed a glut and very little business was done, but in spite of the fall of revenue from this fishery, research on Chank Fisheries was continued with considerable success.

The activities of the Department comprise, besides administration and scientific research, supply of biological specimens to universities and educational institutions in India, anti-malaria work by the introduction of larvicidal fishes, socio-economic work such as education of fishing people, establishment of co-operative societies for their benefit, etc., propaganda in the form of rural pisciculture, exhibitions, etc., and fishery legislation. Under the heading of "Publications" attention may be directed to *Bulletin on Marketable Fishes* and *A Popular Account of Fishery Activities* which, when published, will greatly enhance the prestige of the Department and will enable the lay public to evaluate for itself the advantages it can receive from the proper working of a scientific fisheries department.

The Expenditure and Revenue of the Department shows an adverse balance of Rs. 1,27,086–4–1, but when the vast advantages the Department confers on the fishing people and the production of a healthy, nutritious diet for the general public are taken into consideration, the subsidy of a lakh and a quarter of rupees from the Provincial revenues seems insignificant. But it seems that in spite of considerable efforts on the part of the Department the real significance of the fisheries is still not fully realised. In the opening paragraph of the introduction the Director says that "indications are not wanting that Fisheries as a latent source of food and wealth has not so far received adequate recognition. Within the last fifteen years the question of the continuance of the Department as a national service has been pressed on Government's attention on no fewer than six occasions. The findings of the census of 1931 that agriculture has reached its maximum production under present conditions and the Presidency can no longer feed itself, is a serious warning to the country that attention should now at least be directed to fisheries as the only other prime source of food-supply, and as a valuable addition to the country's wealth." It may here be recalled what Surgeon-Major Francis Day observed in his *Report on the Fresh Water Fish and Fisheries of India and Burma* (p. ccxxxvii). He stated "how great must be the moral responsibility of legislators, who, living amongst a population such as exists throughout India, more than half of whom would consume fish could they procure it, have permitted the depopulation of the fresh-water fisheries, and allowed the destruction of so great a source for the supply of animal food. Now that it clearly appears millions would eat fish could they obtain it, surely the re-population and future protection of these fisheries will be considered an important subject for consideration as a means of supplying loss of physical powers and nervous energy." The value of this unlimited food-supply of high quality becomes inestimable during famines when crops fail owing to floods or drought. Attention may here be directed to the fact that the Royal Commission on Agriculture made strong recommendations for the economic exploitation of the fisheries in India principally with the idea of improving the physique of the agriculturists whose ill-balanced diet received the attention of the Commission.

Dependence of the "Visibility" of an Object on its Apparent Size.

By C. S. Karve, B.Sc.,
Fergusson College, Poona.

In choosing suitable objects at different distances as landmarks for making observations on "visibility" in meteorological practice, one of the conditions that is considered desirable is that the objects should subtend at the eye of the observer about the same angle. It is also generally known that other conditions remaining the same, an object of smaller angular size ceases to be visible at a shorter distance. In order to obtain some definite information regarding the manner in which our estimate of visibility would be affected if the size of the object is allowed to vary, some experiments were carried out during the last few months in the grounds of the Fergusson College, Poona. The objects under observation were square sheets of white paper pasted on a large blackboard. This ensured uniformity of background and similarity of illumination. The size of the board was about $5' \times 4'$. Five different sizes of paper were used, the sides of the squares being 2·75 cm., 5·5 cm., 11 cm.,

22 cm. and 33 cm. Observations were made at different distances from the board nearly normally with the help of a Wigand Step-Visibility-Meter ('Stufen-sicht-messer'). The distance of the place of observation from the object varied from 50 metres to 180 metres.

The visibility meter consists of a series of 14 ground-glass discs of graded degrees of mattness, any one of which can be placed in front of the observer's eye. A measure of the distinctness with which an object is seen is given by the number of the disc through which, when the object is viewed, it becomes just unrecognisable from the surroundings. Wigand fixed the scale of the instrument in such a way that when an object, having very good contrast from the surroundings is viewed in perfectly clear weather through disc No. 14·3, the object would become just invisible. The grading of the discs is such that two discs with numbers m and n when superposed produce the same effect as a single disc of number $m+n$.

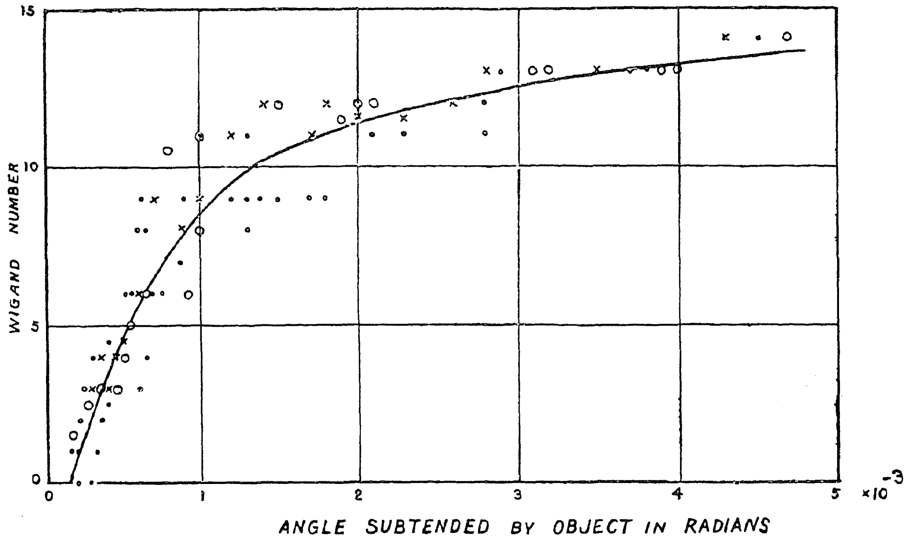

Fig. 1.

White object against black background. Illuminated by sky-light.

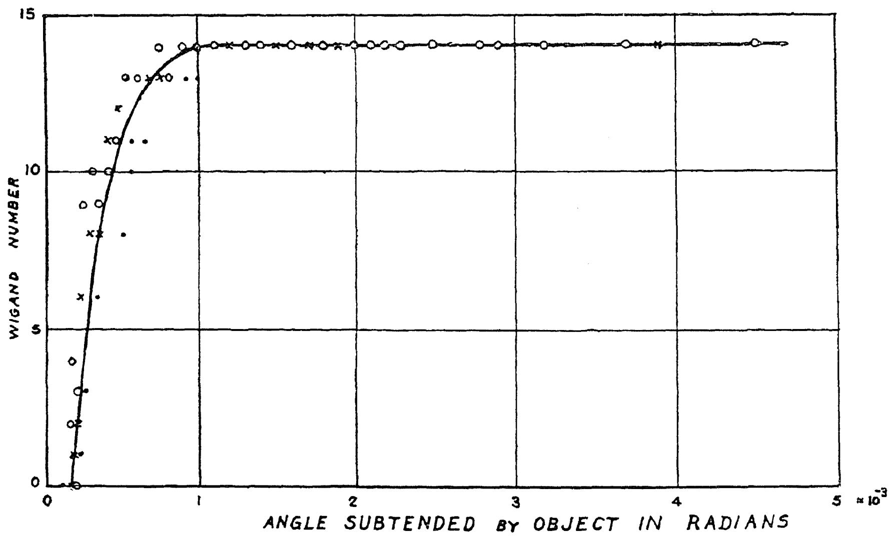

Fig. 2.

White object against black background. Illuminated by sunlight.

The observations taken on a number of *very clear* mornings with different sizes of objects and different distances of observation are plotted in Fig. 1. Separate signs are used to indicate observations taken on different days. The continuous line is the mean curve drawn through the plotted points. In order to bring together all observations to the same scale, the angular size of the object at the observer's eye is plotted against the distinctness with which the object was seen (as measured by the disc-number of Wigand Visibility-Meter at the threshold of recognition). It will be seen that as the object increases in size from a very small value, the distinctness increases rapidly up to an angular size of about $1 \cdot 5 \times 10^{-3}$ radians or (5′ of arc) and thereafter the increase is much less rapid. The Wigand number practically approaches the value 14 when the angle is 5×10^{-3} radian or 17′ of arc. 0·5° seems to be a safe lower limit of size for visibility landmarks.

As one may expect, there is a dependence of visibility on the lighting of the object. Another series of observations taken in the evening, also in very clear weather but with sunshine falling on the board, are plotted in Fig. 2. In this case, as the apparent size of the object decreases, the distinctness is little affected until a size of about 3′ is reached after which it diminishes very rapidly. The difference between the curves when the illumination on the object is altered shows that if a distant tower or pillar is chosen as a visibility landmark, the estimated visibility will, other conditions remaining the same, depend also on the relative position of the sun, observer and object.

The bearing of these results on the problem of determining vertical visibility in the atmosphere by observations of pilot balloons is obvious but this question is complicated by a number of other factors, such as the size and colour of the balloon, the colour and brightness of the sky, the altitude of the balloon at which observations are taken, the manner in which the transparency of the atmosphere varies in the vertical, etc.

The Wigand Visibility-Meter used for the above observations was kindly loaned by the India Meteorological Department. The observations were taken at the suggestion of Dr. K. R. Ramanathan, Meteorologist.

Occurrence of *Derris elliptica* in India.

By S. Krishna and T. P. Ghose,

Chemical Branch, Forest Research Institute, Dehra Dun.

DERRIS root is at present an important article of trade since it is a potent insecticide, acting both as a contact and stomach poison to aphids and caterpillers infesting vegetables and fruits. Moreover, being non-poisonous to man and animals, it is preferred to arsenical and other poisonous insecticides used as spray or dust on vegetable food products. In animal husbandry it has proved very effective against "Warble Fly", poultry pests such as "Red Poultry Mite" and it forms the basis of some proprietory sheep dips. In view of these uses there is a growing demand for Derris and the supply of good quality Derris root does not appear to be in excess of the demand at the present moment.

Derris is a general name applied to several species of Derris, native, throughout the Tropics. But *Derris elliptica* and *Derris malaccensis* are at present the chief source of Derris of commerce and they come mostly from Malaya, Sarawak, British North Borneo and the Dutch East Indies where the cultivation of these species has greatly been increased—within recent years. In Philippines,[1] Belgian Congo,[2] New Guinea[3] and other places where *Derris* species are indigenous, attempts are being made to increase the production by cultivation of suitable strains.

Several species of Derris are known to occur in India; of these *Derris robusta* and *Derris scandens* were examined by McIndoo, Sievers and Abbott[4] in 1919 and both were found to be avoid of insecticidal properties. *Derris uliginosa*, which occurs in fair abundance in certain parts of Bengal and Assam, was examined by Tattersfield in 1926–27 and was found to possess very little insecticidal properties. *Derris elliptica*, which is known

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[1] *University of the Philippines Natural and Applied Science Bull.*, Oct. 1933, **3**, No. 2.

[2] *Bull. Agricole du Congo Belge*, 1934, **25**, No. 3.

[3] *The New Guinea Agri. Gazette*, 1935, **1**, 38.

[4] *Jour. Agr. Research*, 1919, **17**, 177-200.

established knowledge in spermatogenesis and secretory phenomena.

In the earliest oocytes of some animals the Golgi apparatus is said to occur as a mass without any differentiation into an osmiophilic region and an idiosome. In some other early oocytes as well as in growing ones the apparatus has been described in a variety of ways. Granular, vesicular and batonette shapes are commonly referred to. In the ring and batonette shapes differentiation into chromophilic and chromophobic regions have been observed. The question arises whether all these could be derived from the Golgi mass without any differentiation into osmiophilic and osmiophobic regions or whether the shape is fixed. Curiously enough Nath[6] and Harvey[7] seem to consider that the shape is fixed. Nath in the earliest oocytes of scorpions[8] described "a few clearly-defined curved rods lying on one side of the nucleus". But in *Culex*,[9] *Dysdercus*,[10] *Periplaneta*[11] and *Pheretima* he describes vesicles and especially in *Pheretima* he attempts to interpret the various other shapes that he observed as caused by improper fixations and optical sections. In a recent paper[12] he mentions that the Golgi apparatus is polymorphic, but I have not been able to make out whether that applies to oogenesis also.

Harvey, on the other hand, considers that there can only be one form of Golgi apparatus in invertebrates and that resembling the dictyosomes. He had previously described in the oogenesis of *Ciona intestinalis*[13] the Golgi apparatus occurring as "argentophil vesicles and irregular masses" but in a recent paper he has ignored his previous results. The reason for such a procedure becomes apparent when he remarks, while criticising Nath's work, that "there can be no connecting link between these vesicles and the net-like Golgi apparatus characteristic of vertebrate cells which is the fundamental absolute to which all questions of the form of Golgi apparatus must ultimately be referred". Thus the very existence of the other shapes recorded are questioned. In this he does not attempt to interpret or refer to similar shapes observed by other workers in spermatogenesis and secretory cells of both vertebrates and invertebrates.

That hollow spheres have an existence could be made out from the fact that the main reason of Hirschler[14] for postulating an "apparatinhalt" was that in the case of hollow Golgi spheres the central contents could not possibly be the same as the external cytoplasm. Hirschler had described the Golgi apparatus in the eggs of *Ciona intestinalis* as having ring and half-ring shapes. Gatenby[15] records in some Lepidoptera batonettes becoming converted into rings. Beams and Goldsmith[16] in the salivary gland cells of *Chironomous* present photomicrographic evidence of ring and half-ring shapes occurring side by side. Finally, Bowen's[17] figures of the acroblast and the Golgi remnant in *Euschistus euschistoides* show that in the case of the dictyosome shaped like a U, sections in some particular planes produce rings as the Golgi body necessarily has three dimensions.

It is quite possible as my experience has shown,[18,19] that in some eggs the shape is fixed throughout oogenesis. But that fact alone does not entitle one to define the shape of the Golgi bodies as fixed in all types of eggs. Variations in the shapes of the network—like Golgi apparatus of vertebrate somatic cells led Bowen[20] to conclude that the Golgi apparatus may assume any shape, the reticulum or network being only one expression of its protean appearance. How different is this conception from that of Nath and Harvey!

The Golgi apparatus of secretory cells and spermatocytes is in no way different from

6 Nath, V., *Quart. Journ. Micr. Sci.*, 1930, **73**, 477–507.

7 Harvey, L. A., *Proc. Roy. Soc. London*, (B), 1931, **107**, 414–441–455.

8 Nath, V., *Proc. Roy. Soc. London*, (B), 1925, **98**, 44–58.

9 Nath, V., *Zeit. zellf. mikr. Anat.*, 1929, **8**, 655–690.

10 Bhandari, K. G., and Nath, V., *Zeit. zellf. mikr. Anat.*, 1930, **10**, 604–624.

11 Nath, V., and Mohan, P., *J. Morph.*, 1929, **48**, 253–279.

12 Nath, V., *Quart. Journ. Micr. Sci.*, 1933, **76**, 129–143.

13 Harvey, L. A., *Proc. Roy. Soc. London*, (B), 1927, **101**, 136–162.

14 Hirschler, J., *Arch. mikr. Anat.*, 1918, **91**, 140-182.

15 Gatenby, J. B., *Quart. Journ. Micr. Sci.*, 1917, **62**, 407–465.

16 Beams, H. W., and Goldsmith, J. B., *J. Morph.*, 1930, **50**, 497–517.

17 Bowen, R. H., *Biol. Bull.*, 1920, **39**, 316–359.

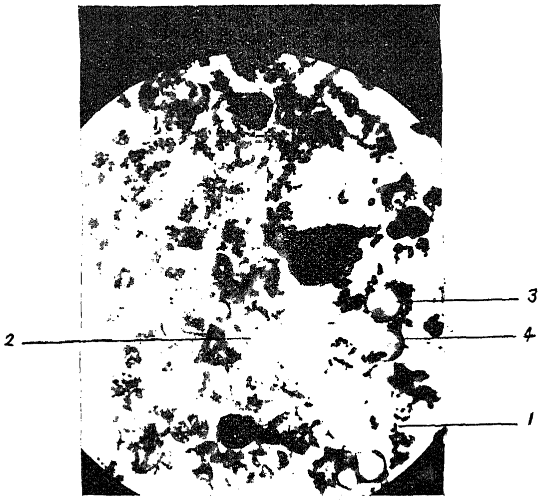
18 Subramaniam, M. K., *Proc. Ind. Acad. Sci.*, 1934, **1**, 6, 291–316.

19 Subramaniam, M. K., and Gopala Aiyar, R., *Proc. Ind. Acad. Sci.*, 1936, **3**, 3, 175–195.

20 Bowen, R. H., *Anat. Rec.*, 1926, **32**, 151–193.

A portion of *Clibanarius* egg showing the various stages mentioned in text.

Nassonov × 1,800

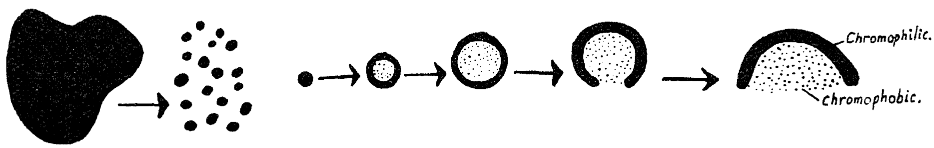


1. Golgi grain. 2. Golgi vesicle. 3. Rupture of vesicle. 4. Batonette.

that I have found between a mass and a typical batonette.

In the eggs of *Clibanarius*[21] and *Stomopneustes*[22] granules, vesicles and batonettes occur side by side at certain stages. But from their order of appearance and from the fact that no case of a *de novo* origin has ever been noted by me or others and also from the occurrence of distinct and unmistakable intermediate stages, I believe it will be interesting if all the stages could be demonstrated in a single photomicrograph and thus the position cleared, in regard to the inter-relationship of the various shapes at the same time.

My own conception of the batonette formation is this. The Golgi mass occurring in the earliest oocyte breaks up into a number of granules in which, as in the mass itself, there is no chromophobic component. These granules when they enlarge into vesicles become differentiated into osmiophilic and osmiophobic regions. Rupture of the vesicles takes place resulting in the formation of a



Golgi mass. → Grains. ⟶ Vesicles. → Rupture of vesicle. → Batonette.

those found in the various other tissues of the body because it is the Golgi bodies in the eggs which give rise by division and distribution to the Golgi apparatus of all the cells in the body. Hence we are faced with the question how the Golgi bodies having the same origin can be assigned different shapes in different cells. Either the diversity of shape should be accepted or a *de novo* origin of the Golgi apparatus in different cells should be proved. The latter possibility being negligible the only recourse will be to accept the former one. If the diversity of shape is accepted, naturally there should be intermediate stages between the Golgi mass, granules, vesicle, batonette and the network. Leaving the origin of the network for a later communication I shall consider here the nature of the intermediate stages batonette in which the idiosome is in relation with the cytoplasm. In the photomicrograph and the accompanying text-figure my conclusions are given in a pictographic manner.

It is true that such a regular series of stages leading from the Golgi mass to a typical batonette is of rare occurrence and hence extreme caution is necessary in coming to conclusions. It seems that the more one learns about the shape or function of the Golgi bodies, the more evident does it become that its shape or function at first described in many patterns is gradually resolved into numberless variations of a single basic procedure.

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[21] Subramaniam, M. K., *Journ. Roy. Micr. Soc.*, 1935, 12–27.

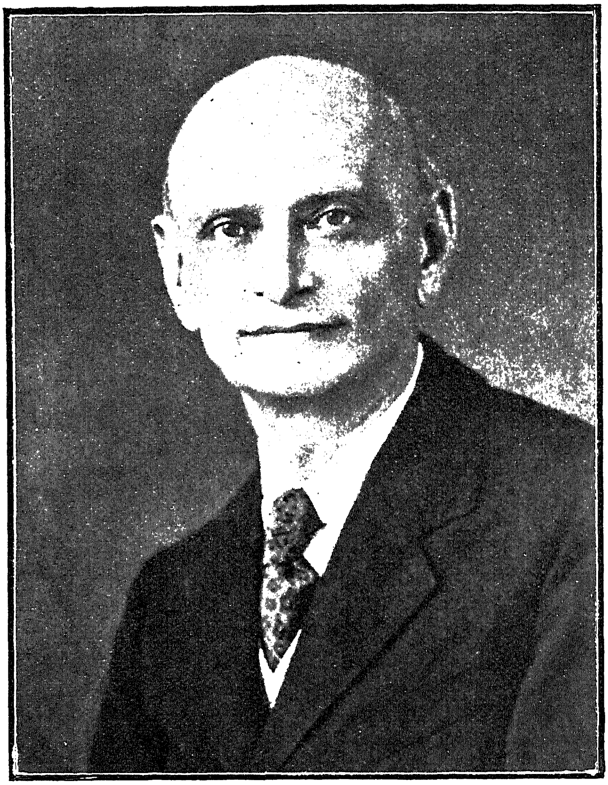
[22] Subramaniam, M. K., and Gopala Aiyar, R., *Zeit. zellf. mikr. Anat.*, 1936, **24**, 4, 576–584.

Obituary.

Dr. N. A. F. Moos, D.Sc., L.C.E., F.R.S.E.

THE recent death of Dr. Moos recalls to memory the century-old history of the Bombay Observatory and the part he played in its development and growth during the period of nearly a quarter of a century from 1896—1919, when he held the post of Director of the Institution.

The present site of the Observatory at Colaba was selected and the grounds enclosed in 1823. In common with many other observatories, the Colaba Observatory began as an Astronomical Observatory. In 1841, magnetical and meteorological work were added to the activities of the institution but it was only from 1846 that the Observatory was properly equipped and began to take regular observations in magnetism and meteorology. Although at first there was a whole-time Astronomer in charge of the Observatory, later the superintendence of the Observatory was carried on as part-time work by a college professor and then by officers in the Royal Navy. In 1864 a Committee was appointed by the Government to enquire into the working of the Observatory and recommend its future programme of work. They recommended, among other things, that for doing useful scientific work a primary necessity was whole-time control by a skilled Superintendent. Except for the work required in connection with the accurate determination of time, it was not considered desirable to have an astronomical programme. In 1865 Mr. Charles Chambers was appointed as the first full-time Superintendent. The Observatory was, in a short time, equipped with autographic instruments giving continuous records of magnetical and meteorological elements. Under the direction of Mr. Chambers the Observatory soon entered upon an era of real scientific activity both in regard to the collection of accurate data and to their discussion. Mr. Chambers contributed a large number of papers (about 32) on the subjects of Terrestrial Magnetism and Meteorology, many of which were published in the *Transactions of the Royal Society*. He also wrote a Memoir on "the Meteorology of the Bombay Presidency".



Dr. N. A. F. Moos, D.Sc., L.C.E., F.R.S.E.

Mr. Charles Chambers, F.R.S., died suddenly in 1896 and Dr. N. A. F. Moos was appointed to succeed him as Director. Dr. Moos worthily upheld the tradition of scientific work established by Mr. Chambers and added to the international reputation of the Observatory. In 1900 the magnetic work of the Observatory was threatened by the proposed introduction of electric traction in the city of Bombay and to preserve the continuity of the long Bombay record it became imperative to shift the magnetic work to a protected site in the neighbourhood. Such a site was secured at Alibagh, about 19 miles to the south-east of Bombay and after the construction of necessary buildings, which include a double-walled constant temperature room, new magnetic instruments were installed and duplicate records for two years at the old and new

sites were secured for comparison purposes before the electric service actually commenced its operations. Like Mr. Chambers, Dr. Moos, in addition to publishing the usual observatory data in periodical volumes, also made a large number of valuable discussions on these and other allied data. His greatest effort however was the publication of two volumes of the work entitled *Colaba Magnetic Data 1846-1905*. The observational material of this remarkable series of magnetic observations extending over 60 years are presented in the first volume and their discussion follows in the second. The reader is at first overwhelmed by the mass of figures in tabular form which are presented for his study but this feeling soon gives place to one of admiration for the enthusiastic perseverance of the author in carrying through such a tremendous piece of work to its conclusion and the thorough manner in which the results are discussed. The volumes form an outstanding contribution to the science of Terrestrial Magnetism and remain a very valuable storehouse of information for students of Terrestrial Magnetism.

Since 1905 magnetic data have now accumulated at the Alibagh Observatory for a further period of 31 years and it is hoped that the India Meteorological Department, which now completely controls the internal as well as the external activities of the two Observatories, will find a suitable opportunity to bring the results and their discussion up-to-date.

Dr. Nanabhai Ardesher Framji Moos was born on the 29th October 1859. He took his degree in Engineering from the Poona College of Science in 1878. Immediately after his graduation he served the Bombay Municipality as an Assistant Head Superintendent of Engineering but finding no attraction in the post he soon joined the staff of his college where he served for five years. Not satisfied with the prospects that were then open to an Indian in the Educational Department he went to Europe for higher education, joined the Edinburgh University and took there in 1886 the degree of Bachelor of Science with distinction. In Edinburgh he won several medals and also the Bursarship of the Highland Society of Scotland; he stood first in the competition examination for the Van-Dunlop Scholarship in Science but as he had not put in the requisite number of terms at the University, could not secure it. The impression he created at the Edinburgh University and the recommendations he carried from Sir W. Muir, the Principal of the University, helped him in securing the acting post of Inspector of Factories on his return to Bombay. Soon after he reverted to his post in Poona College and was thence transferred to the Chair of Physics in Elphinstone College, Bombay. In 1892 he got the substantive post of Inspector of Factories but finding the post uncongenial to his academic and scientific tastes he sacrificed the higher emoluments of the post and returned to his College professorship.

On the death of Mr. Charles Chambers, F.R.S., in 1896 Dr. Moos was appointed Director of Bombay Observatory, a post which he held for 24 years. It falls to the lot of few scientific men to set up new first class observatory but Dr. Moos was fortunate in having two such opportunities in the building up of the New Magnetic Observatory at Alibagh and of the Time Ball Observatory at Karachi.

Dr. Moos' investigational work was mainly directed to the sciences of Terrestrial Magnetism and Seismology as during his tenure of office and in effect since 1888, the work of the Meteorological Reporter at Bombay was placed under the control of the Government of India and was put in charge of the local Superintendent of Telegraphs as a half-time officer.

Dr. Moos held the membership of several scientific societies and was the recipient of many honours. He was a Doctor of Science of Edinburgh University, a Fellow of the Royal Society of Edinburgh, Fellow and Honorary Member of the Highland Society of Scotland and a Fellow of the Chemical Society. Besides doing his official and scientific work, Dr. Moos took a prominent part in the University and civic life of Bombay. He served the Bombay University for a number of years as an examiner, a Fellow of the Syndicate and a Dean of Science. He was a member of the Board of Studies in Engineering and Geology and of the Faculty of Science and the Academic Council. As a member of the Senate he took a keen interest in important educational problems. He was a representative of the University on the Indian Institute of Science, Bangalore, the Engineering College, Poona, and the Prince of Wales Museum, Bombay. As a member of the Bombay Municipal

Corporation representing the University for six years his services were much appreciated. Even after his retirement from official duties in 1919 at the age of 60 years Dr. Moos continued to take a keen interest in meteorological, magnetical and seismological problems. He was always alert and active till he entered rest on 12th March 1936 at the age of 77 years.

The writer of this article was associated with Dr. Moos and his work for 16 years from 1903 to 1919 and cherishes grateful memories of the very kind and paternal interest which he took in his staff in all matters connected with their welfare. He knows Dr. Moos as a fearless exponent of the views which he considered to be right and in the true interests of his beloved Observatory; he knows him also as a keen upholder of his views in his other educational and civic activities and above all as an ideal head of a family and of a working scientific institution.

RAO SAHEB M. V. UNAKAR.

Centenaries in June 1936.

Regiomontanus, Johann, 1436-1476.

JOHANNES MULLER, who is better known by his pseudonym Regiomontanus, was born at Konnigsberg, on June 6, 1436. According to the traditional estimate, Regiomontanus was for long regarded as "the most learned astronomer that Europe had yet produced". He was educated at Vienna. He received the Master's degree in 1457 and became a lecturer the very next year. He lectured on Euclid and on perspective geometry. He also colloborated with his teacher George Peurbach in correcting and revising the Alphonsine Tables.

ADOPTS THE HINDU IDEA OF *Sine*.

In 1462, Cardinal Bessarion persuaded him and his teacher to prepare a Latin translation of Ptolemy's *Almagest*. Peurbach died after translating the first six books and Regiomontanus completed the translation of the remaining seven books. This undertaking took him to Italy where he stayed for six years. While at Italy, he also wrote his Trigonometry entitled *De Triangulis*. This is said to be the earliest modern systematic exposition of trigonometry. He adopts, for the first time, the Hindu *Sine* in place of the Greek *chord of double the arc*. His oration at Padua on the history of mathematics is summarised by Cantor in his *Geschichte der Mathematik*. He is also said to have observed a total eclipse of the moon at Padua on April 2, 1464.

HALLEY'S COMET AND *Ephemerides*.

After being a professor in the University of Pressburg, which was established in 1467, he settled at Nurenburg in 1471, where he had for his pupil and patron a wealthy burgher, Bernhard Wattler, who built an observatory for him. Regiomontanus himself is said to have constructed the necessary instruments for this observatory. It is claimed that his observations of the great Comet of 1472, since called Halley's Comet, supplied the basis of the modern study of comets. His patron established a printing press, from which Regiomontanus issued a series of popular calendars. In 1474, his *Ephermerides* for 1474–1506 was published. This book explained the method of lunar distances for determinining the longitude at sea. Columbus is said to have used a copy of this.

HIS WRITINGS.

In 1475, Pope Sixtus IV invited him to Rome to reform the Calendar. He was made Bishop of Regensburg, but died at Rome on July 6, 1476, while still at the prime of his life. At his death, Regiomontanus left a long list of books, which he had already completed or was at work upon or intended to print for the first time. These included editions or new translations of various mathematical classics, such as the works of Ptolemy, Euclid, Apollonius, Hyginus and Theon. Astrological treatises also figure prominently in the list. Many of them were printed after his death, by his patron Wattler.

S. R. RANGANATHAN.

Coulomb, Charles Augustin, 1736-1806.

COULOMB, the French physicist, was born in Angouleme on June 14, 1736. He studied mathematics and science in Paris and then entered the army. After serving in the West Indies for seven years, he returned to Paris in 1776 and in the thirteen years which followed up to the outbreak of the great Revolution, he carried out his fundamental electric and magnetic investigations,

They brought him recognition and membership of the Academy.

COULOMB'S LAWS.

A good number of electrical and magnetic observations had accumulated for centuries and the additions made to this unco-ordinated heap were remarkable during the century that preceded Coulomb. Various attempts had been made to obtain a general and comprehensive view of them and to discover the law of attraction between magnetic poles and between electric charges. But the credit of having enunciated them in exact terms goes to Coulomb. The laws of Coulomb are justly famous both for their simplicity and for the rare masterpiece of experimental skill, which formed their basis.

THE TORSION BALANCE.

The first step towards the discovery of his laws lay in the invention of the torsion balance in 1777. To improve the delicacy of this balance, he investigated the force of torsion and the elasticity of thin metallic and silk fabrics. He found the forces required to twist them to be proportional to the angle of twist, to the fourth power of the diameter of the fibre and to the reciprocal of the length of the fibre but to be independent of the load on the wire. This was published in 1784. With this result as the basis, Coulomb perfected his torsional balance to measure forces which were very small and fleeting. The torsion balance was later used by Cavendish in his important investigation of gravitation. The principle of this balance has since been used in a large number of finest measuring instruments such as galvanometers and electrometers.

HIS OTHER INVESTIGATIONS.

Coulomb was also active in other directions such as the laws of sliding friction and the internal friction of liquids. In the investigation of the latter, which he made in 1801, he made use of the torsional oscillations, executed by cylinders hung up in the liquid.

In 1789, at the outbreak of the Revolution Coulomb resigned all his official posts and retired to his small estate near Blois and devoted himself to scientific research. Napoleon, who had restored order, gave him back his former posts in which he worked devotedly until his death in Paris on August 13, 1806.

S. R. RANGANATHAN.

Ampere, Andre Marie, 1775-1836.

A. M. AMPERE, who was called the Newton of Electricity by Maxwell, was born in Lyons on January 22, 1775. He was brought up alone in the country and his education was got, with a little assistance from his father, mainly through books. He showed a wide range of mental activity and an extraordinary mathematical ability. The beheading of his father in 1793 filled him with apathy and for some time he wandered distracted and planless. His marriage at the age of twenty-four gave his life a definite direction again and he took up a teaching post near Lyons. His wife died within four years after their marriage and this event threw him again into a mood of life-long sadness.

FIRST WORK.

Ampere made his first appearance in the scientific world in a short work entitled *Considerations sur la Theorie Mathematique du Jeu*, in which the question of the safety of habitual and indefinite play, either against a single person of greater fortune, or indifferently against any number of persons is discussed in a form full of warning to those by whom gambling is pursued as an occupation. This book brought him recognition and in 1809 he became Professor of Mathematics at the Ecole Polytechnique in Paris. Here he continued his scientific researches with great diligence and published memoirs on the integration of partial differential equations and on other subjects, which show a profound knowledge of some of the most refined and difficult artifices of analysis. The published papers of Ampere number fifty-five, of which three are joint papers.

FATHER OF THE SCIENCE OF ELECTRO-DYNAMICS.

Ampere's fame mainly rests on his memoirs on the mathematical theory of Electric-magnetism, which are remarkable for the skill and ingenuity with which the powers of analysis are brought to bear on subjects apparently the most remote from their operation. Oersted's discovery, in 1820, of the magnetic properties of an electric current decided the direction in which Ampere's gift for scientific research was to develop. Only a few months later, on the

2nd October 1820, Ampere presented to the French Academy of Sciences a paper in which he showed that not only is there a mechanical force between an electric current and a magnet but that there is a mechanical force between two neighbouring electric circuits. This brilliant paper was followed by quite a number of others, in which various details were worked out.

Clark Maxwell's Estimate.

In the words of Clark Maxwell, the whole theory and experiment seems as if it had leaped full grown and full armed, from the brain of the "Newton of electricity". It is perfect in form, and unassailable in accuracy, and it is summed up in a formula from which all the phenomena may be deduced and which must always remain the cardinal formula of electro-dynamics. Ampere's memoirs are a splendid example of scientific style in the statement of a discovery.

His Personality.

Ampere died at Marseilles in June 1836. He was a man of great simplicity of character. He took no part in the cabals and jealousies which too frequently disturb the peace of the world of science. He was universally respected and beloved for his great integrity and the kindness of his affections. He retained a childlike disposition up to his old age. He was often tortured by doubts in small matters as well as great ones, so that life, in spite of all the recognition that it brought him, was by no means always satisfactory, a fact expressed in the epitaph chosen by himself *tandim felix*, *i.e.*, Happy At Last.

S. R. RANGANATHAN.

Award for Scientific Manuscript.

A CASH award of $ 1,000 is offered by the Williams & Wilkins Co., Mt. Royal and Guilford Aves., Baltimore, Md., for the best manuscript on a science subject, presented before July 1, 1937. The publishers put no limitations on the subject-matter or manner of handling, and none on eligibility for the award. The manuscript must be in English and "of a sort calculated to appeal to the taste of the public at large". The desired length is given as 100,000 words.

While any manuscript on a science subject will be considered, it is expected that the author will prove to be a man or woman engaged in a scientific pursuit and who is possessed of the requisite literary skill to interpret science for that portion of the public which reads books.

To assure authority, the publishers have enlisted the services of some 25 or 30 advisers—men of science of wide reputation and assured competence. One or more of these advisers will pass upon each manuscript from the view-point of soundness and accuracy. The award will lie in the joint discretion of four judges selected with a view to their especial qualification in choosing the sort of book that will appeal. These are: Joseph Wheeler, Librarian of the Pratt Library in Baltimore, and Chairman of the Book List Committee of the Association for the Advancement of Science; Harry Hansen, Reviewer and Critic for the *New York World-Telegram* and *Harpers Magazine*; Lyman Bryson, Professor of Education of Teachers College, Columbia University, and Director of the "Readability Laboratory"; and David Dietz, Science Editor of the Scripps-Howard newspapers.

Further details concerning the award may be had by addressing the publishers. (News Edition, *Ind. Eng. Chem.*, 1936, 28, 195.)

Letters to the Editor.

CONTENTS.

The Crystal Structure of Potassium Bicarbonate, $KHCO_3$.

THE crystal structure of potassium bicarbonate, $KHCO_3$, has been studied by the usual X-ray methods with the help of fixed-film and moving-film cameras. As described in Groth's *Chemische Krystallographie*,[1] the crystal is monoclinic prismatic, with the following elements:—

$a:b:c = 2 \cdot 6770 : 1 : 1 \cdot 3115$; $\beta = 103° \ 25'$.

Rotation photographs of single crystals of $KHCO_3$ were taken about the three crystallographic axes, in a camera of 5 cm. radius, and the axial lengths were calculated therefrom. Weissenberg photographs about the 'b' and 'c' axes were taken in the Seemann goniometer, and analysed by the well-known graphical method.[2] The dimensions of the unit cell are thus found to be

$$a = 15 \cdot 01\text{A}, \; b = 5 \cdot 69\text{A}, \; c = 3 \cdot 68\text{A};$$
$$\beta = 104° \ 30' \text{ (directly measured from Weissenberg photograph).}$$

They correspond to the axial ratios

$$a:b:c = 2 \cdot 64 : 1 : 0 \cdot 647,$$

which agree with Groth's values, except that the 'c' axial length is halved. Taking the density as $2 \cdot 17$ we have 4 molecules of $KHCO_3$ per unit cell.

Over hundred reflections have been observed. Reflections ($h0l$) are absent if h is odd, and reflections ($0k0$) are absent in odd orders. Consequently the symmetry plane is a glide plane with a translation $a/2$, and the two-fold axis of rotation is a screw axis with a translation $b/2$. It follows therefore that the space group is C_{2h}^5 ($P2_1/a$).

The absence of reflections from ($hl0$) when h is even, and the weak reflections of almost all the planes ($hk0$) when $(h+k)$ is odd, require, that the potassium atom, which is the predominant scatterer, lies practically in the (010) plane. Strong reflections from the planes (400), (401), ($40\bar{1}$), etc., suggest that the CO_3 group should be near the plane (400). Some unpublished data for the magnetic susceptibilities of single crystals of $KHCO_3$ by Asutosh Mookherji of this laboratory also point to the same conclusion. A detailed account will shortly be published elsewhere.

JAGATTARAN DHAR.

Indian Association for the Cultivation of Science,
210, Bowbazaar Street,
Calcutta,
June 1, 1936.

[1] 2, 191.

[2] *Zeit. f. Kryst.* (A), 1933, 84, 327.

Effect of Temperature on the Raman Spectrum of CCl_4.

I HAVE investigated the Raman spectrum of liquid CCl_4 over a wide range of temperatures extending from the room temperature up to 200° C. Rise of temperature brings about several progressive and striking changes in the Raman spectrum of this substance, as can be seen from the photograph reproduced below.

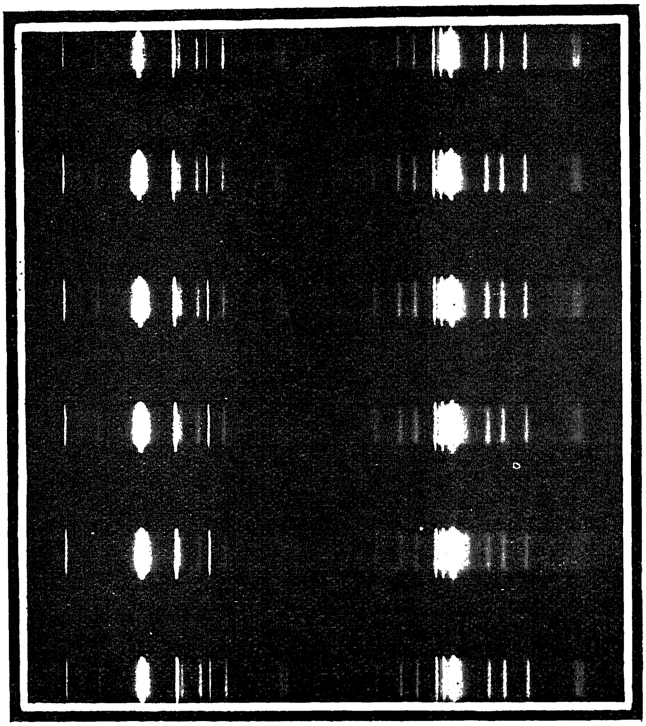


Fig. 1.

(1) The doubly degenerate Raman line at 218 cm.$^{-1}$ and the triply degenerate frequency at 314 cm.$^{-1}$ become considerably broad and diffuse as the temperature is elevated.

(2) The pair of Raman lines at 762 cm.$^{-1}$ and 790 cm.$^{-1}$ forming the triply degenerate frequency, which are very well resolved at the ordinary temperature become rapidly diffuse as the liquid is heated.[1] In the spectrum photographed at 200° C. these lines have merged into one another into a single broad and diffuse band.

(3) The totally symmetric vibrational Raman line at 459 cm.$^{-1}$ does not seem to be appreciably influenced by temperature.

(4) In the Raman spectrum of the liquid at 200° C. the Stokes lines are markedly weaker than those at room temperature. This observation is in contradiction to Placzek's theory which predicts an increase of intensity for the Stokes as well as the anti-Stokes components with rise of temperature. It also appears that the increase in intensity of the anti-Stokes components, if any, is much less than that demanded by the theory.

The increased width and diffuseness of the degenerate vibrations is presumably connected with the greater rotational freedom of the molecules at higher temperatures. The reason for the fall of intensity of the Stokes components with rise of temperature is in all probability due to diminution of $\left(\frac{\partial\alpha}{\partial q}\right)_0$ for the higher vibrational states whose population is more dense at higher temperatures. The full significance of the results will be discussed in detail in a paper which will shortly appear in the *Proceedings of the Indian Academy of Sciences*.

R. ANANTHAKRISHNAN.
Department of Physics,
Indian Institute of Science,
Bangalore,
June 5, 1936.

[1] See Fujioka, *Sci. Pap. Inst. Phys. Chem. Res., Tokyo,* **1929, 11,** 222.

Particle Size and Magnetic Susceptibility.

COPPER powder of particle size $0 \cdot 4\mu$ was prepared by displacement from copper sulphate by extra pure zinc followed by treatment with hydrochloric acid and fractionation. Copper powder was also prepared by electrodeposition at high current densities. The value of the mass magnetic susceptibility of the two samples was found to be $-0 \cdot 82 \times 10^{-7}$ which is the normal value for copper.

Rao[1] has prepared copper coagula by sparking between copper electrodes in a medium of propyl alcohol or benzene and concludes from his measurements that the diamagnetic susceptibility of this metal is size-dependent, the value increasing with the decreasing particle size. Although Rao started with a sample of copper of 99·964 per cent. purity, an analysis of the resulting coagula was desirable, for the present authors find that a considerable quantity of carbon is included in the coagulum obtained by the above method. Very probably this inclusion is responsible for Rao's results.

The authors have also carried out the susceptibility measurements with lead powders prepared by a variety of methods. The values of magnetic susceptibility measurements are given in the table below after the powders had been washed free from the oxide or other impurities.

	$\times 10^{-7}$
Lead metal	−1·22
Lead powder (0·4 to 0·6μ) (mechanical grinding)	−1·23
Lead powder (displacement from lead acetate by magnesium) ..	−1·22
Lead powder (cathodic pulverisation)	−1·22

From these experiments it is concluded that there is no effect of particle size on the magnetic susceptibility in the case of copper or lead. Similar results are to be expected in the case of the rest of the elements provided no change is brought about in the crystalline structure during powdering or colloidalisation.

Full details will be published elsewhere.

MULK RAJ VERMA.
M. ANWAR-UL-HAQ.

University Chemical Laboratories,
Lahore,
May 28, 1936.

[1] *Proc. Ind. Acad. Sci.*, 1935, **2**, 249.

New Bands of Beryllium Oxide.

WHILE looking out for a new band system of BeF molecule in the near infra-red, we photographed the spectrum of carbon arc in air fed with powdered potassium beryllium-fluoride. Two moderately intense bands in the region 8500–10000 Å degraded to further infra-red were recorded on our plates. On identification, it was found that these bands could not be attributed to the BeF molecule. By introducing beryllium oxide instead of potassium beryllium-fluoride in the lower electrode of the carbon arc these bands were recorded with still greater intensity. This led us to make a search for any of the band systems of BeO molecule. Looking for the latest references on the subject, we found that the red system $^1\pi \rightarrow {}^1\Sigma$ which Herzberg[1] has analysed is deficient in sequences $v' - v'' = +1, 0, -1$, etc., and these evidently must lie above 8204 Å, the limit to which Herzberg has recorded his bands.

In view of the above, we made accurate measurements of wave-lengths by photographing the bands on Kodak IIIQ and Agfa Infra-red plates by means of Hilger's infra-red glass-prism instrument with a dispersion of about 125 A.U. per mm. at 8700 Å and 150 A.U. at 9600 Å. The heads of the new bands were found to have wave-lengths 8710·17 and 9641·9 Å with a possible error of ± 1 A.U. Using Herzberg's zero-line (band origin) equation for $^1\pi \rightarrow {}^1\Sigma$ system, we could tentatively assign the following vibrational quantum numbers to these bands in this system:

Band at	Intensity	v', v''	Observed ν_h	Calculated ν_0 (Herzberg)
9641·9 ..	10	0,0	10368·54	10364·17
8710·17 ..	4	1,0	11477·67	11475·14

From the fact that these bands could only be obtained in the outer flame when BeO salt is excited in the arc and appear along with and similar to the existing bands of the infra-red system, makes us believe that these bands are probably due to BeO molecule. A revised vibrational analysis of the whole system along with the new bands is proceeding.

Royal Institute of Science, Bombay, N. R. TAWDE.
V. S. PATANKAR.
May 15, 1936.

[1] L. Herzberg, *Zeit. f. Phys.*, 1933, **84**, 571.

Opacity as a General Measure of Coagulation.

IN the course of a work to be published shortly in the *Indian Chemical Journal*, it has been observed that the *opacity* of manganese dioxide sol increased '*zonally*,' that is, with marked discontinuities, during coagulation, and that this feature became more pronounced the *slower* the coagulation. The curves in Fig. 1 represent but three typical cases observed during *subsequent* work on the

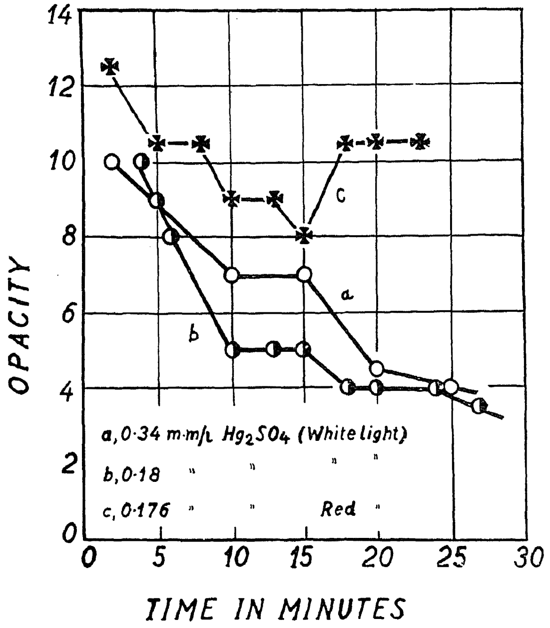


Fig. 1.

kinetics of the same sol, but using a higher colloid content and with solutions of mercurous sulphate as coagulants. These results not only confirm the '*zonal*' change of opacity during coagulation, but show, contrary to expectation from the current theories and general experience, that the opacity has *decreased* during the change. As is usual in these kinetic studies, measurement of the opacity during coagulation was discontinued, as soon as the coagulating system became heterogeneous by flocculation, that is, produced discrete particles of the coagulum sensibly subject to local variations. Curves *a* and *b* refer to experiments made with the white light from a glowing filament; these show that the opacity diminishes with coagulation. Partly different results were noticed when a narrow band, almost monochromatic near Hα, was employed. Curve *c* is one of the results. It shows that there is an initial diminution of opacity followed by a rise, and that both the stages of the change are marked by the '*zonal effect*'. It has been almost a tacit assumption with colloid chemists that coagulation entails an increase of opacity; the adoption of the last quantity as a measure of the degree of coagulation has had a wide and long usage in the field of coagulation kinetics. It is of considerable interest, therefore, to observe, it would appear for the first time in this line, not only a limitation of the general validity of the above assumption, but of the possibly general discontinuous character of the change, independent of whether opacity and coagulation vary in the same sense or otherwise, as was also noticed previously in respect of changes of viscosity and refractive index, during coagulation.[1]

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A. PURUSHOTHAM.
Department of Chemistry,
Benares Hindu University,
Benares,
May 14, 1936.

[1] Joshi and Rao, *Curr. Sci.*, 1936, **4**, 481; also *J. Indian Chem. Soc.*, 1936, **13**, 141.

Fractionation of Starch.

A SURVEY of the literature on amylolysis in relation to the structure of starch reveals the existence of two contradictory views supporting either the homo- or hetero-molecular nature of starch. A study of the mutarotation phenomena accompanying the hydrolysis of starch with different amylases led Kuhn[1] to the view that the starch molecule consisted of both α- and β-glycosidic linkages which were specifically attacked by α- and β-amylases; the sense of the mutarotation was independent of the substrate but was characteristic of the enzyme. van Klinkenberg[2] from his work on the action of integrally pure β-amylase on starch, which hydrolysed a definite fraction (64 per cent.) of the starch substance, advanced the view that the liberation of the α- and β-maltose was not due to the alternative types of hydrolysis of a single substrate, but rather, to the specific hydrolysis of different components of starch which he designated α- and β-starches. A critical examination of the question by Hanes[3] has revealed that, while the main conclusions of van Klinkenberg can be confirmed, no

evidence exists to show that the two components pre-exist in the starch substrate, the possibility of their being fragments of a single molecule not having been disproved. Indeed, the recent work of Freeman and Hopkins[4] has led the authors to reject the hypothesis that starch is composite. Our results on the fractionation of starch furnish some evidence on this question.

A 10 per cent. solution of soluble starch (Riedel-E de Haën A-G., A.R., according to Zulkowski) in 30 per cent. solution of calcium chloride was employed for the fractionation of starch. Absolute alcohol was gradually added to the solution under vigorous stirring to a concentration of 20 per cent.; the precipitate obtained was centrifuged and washed three times with a calcium chloride-alcohol mixture of the same composition as that of the mother liquor. The alcohol concentration of the centrifugate was then raised to 50 per cent. when a further quantity of precipitate was obtained. This was separated and treated in the same way as the first precipitate. A further amount of alcohol was added to the centrifugate to raise the proportion of salt solution to alcohol to 1 : 10. The precipitate was separated and washed. The three fractions were repeatedly washed with alcohol and finally extracted in a Soxhlet with absolute alcohol to remove the last traces of the salt.

The specific rotations of the fractions are tabulated below:—

TABLE I.

	Fraction I	Fraction II	Fraction III
$[\alpha]_D$	169·1	170·5	176·7

The three fractions give different colourations with iodine: thus, Fraction I gives a blue colour and Fraction III a reddish colour with hardly any blue in it; the colour given by Fraction II lies between the two. The three fractions are hydrolysed at different rates by Taka diastase and β-amylase prepared from ungerminated barley. The results obtained with β-amylase employing the same quantities of enzyme and starch are graphically represented (Fig. 1).

The difference between the rates of hydrolysis of Fractions I and III is striking. The quantity of starch hydrolysed in 30 minutes from the three fractions which may be taken as an indication of their β-amylose contents, are respectively

0·5897 ; 0·6414 ; 0·8713 grams.

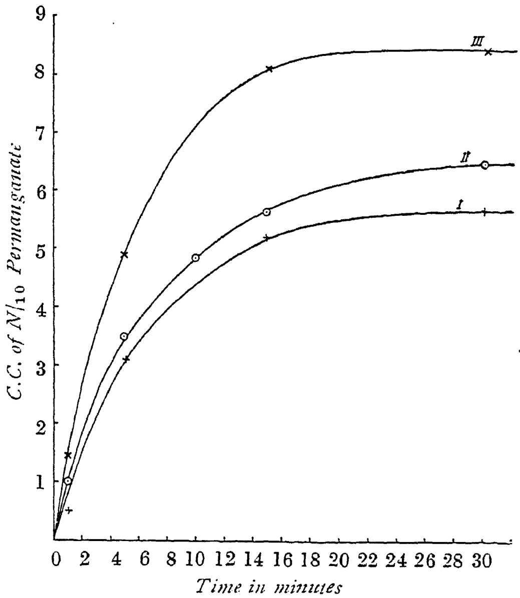

Fig. 1.

Starch 1·0 per cent.; β-amylase 0·5 per cent.

50 c.c. of starch + 10 c.c. of McIlvin's Buffer (pH, 4·8) + 10 c.c. of β-amylase.

10 c.c. used for the estimation of Maltose (Bertrand).

The results clearly show that by a process of solution and precipitation it is possible to fractionate soluble starch into two components differing with respect to their colour reactions with iodine and β-amylose contents. It can be reasonably assumed that the procedure adopted to effect the fractionation does not bring about any chemical change in the starch, and the conclusion that starch is composite and that the components pre-exist in the starch substance, therefore, appears justified.

Further work on the other characteristics of the fractions is in progress.

B. N. SASTRI.
A. KRISHNAMURTI.

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Indian Institute of Science,
Bangalore,
June 10, 1936.

1 Kuhn, *Liebigs' Ann.*, 1925, **443**, 1.
2 van Klinkenberg, *Ergebnisse Enzyme forsch*, 1934, **3**, 73.
3 Hanes, *Can. J. Res.*, 1935, **13B**, 185.
4 Freeman and Hopkins, *Biochem. J.*, 1936, **30**, 451.

The Origin of Cultivated Tobacco.

THE cytogenetic investigations during the last few years supplied evidences for the origin of *Nicotiana tabacum* L. (cigarette and cigar tobacco) and of *Nicotiana rustica* L. (pipe tobacco, Makhorka). Both species represent allopolyploid hybrids, the former being an amphidiploid of *Nicotiana sylvestris* and *Nicotiana tomentosiformis* (syn. *Rusbyi*) or a form of the tomentosa group, while the latter being an amphidiploid of *N. paniculata* and *N. undulata*. *N. tabacum* and *N. rustica* have 48 chromosomes in the somatic cells, while *N. sylvestris*, *N. tomentosiformis*, *N. paniculata* and *N. undulata* have 24 chromosomes in the somatic cells.

The arguments for the above statements are:

1. *For N. tabacum.*—*N. tabacum* haploids have most frequently 24 univalent chromosomes during the first meiotic division, though one or two bivalents also occur. The same chromosome behaviour often occurs in the F_1 hybrids *N. sylvestris* × *N. tomentosiformis*. In the hybrids *N. tabacum* × *N. sylvestris* 12 chromosomes of *N. tabacum* conjugate with the chromosomes of *sylvestris*. The same mode of conjugation was found in the hybrid *N. tabacum* × *N. tomentosiformis*, *i.e.*, 12 bivalents and 12 univalents. The production of triple hybrids with 24 bivalents in crossing *N. tabacum* with the F_1 (*sylvestris* × *tomentosiformis*), *i.e.*, a fully fertile triple hybrid having all three complete genoms of the component species supplied the evidence that 12 *tabacum* chromosomes are homologous with the chromosomes of *sylvestris* while the other 12 are homologous with those of *tomentosiformis*. The production of the amphidiploid *sylvestris-tomentosiformis*, however, represented the final solution of the problem. The amphidiploid *sylvestris-tomentosiformis* has 48 somatic chromosomes. It produces fully fertile hybrids with *N. tabacum*, and has morphological characters the varieties of *N. tabacum* have.

2. *For N. rustica.*—*N. rustica* haploid has usually 24 univalent chromosomes and rarely bivalents are formed, while in the hybrid *paniculata* × *undulata* non, or several bivalents are formed. F_1 hybrids *N. rustica* × *N. paniculata* and *N. rustica* × *N. undulata* form usually 12 bivalents and 12 univalents during the first meiosis (occasionally trivalents are formed too, but this is in agreement with the former data). Trigenomal triple hybrid *N. rustica* × *paniculata* × *undulata* (having complete genoms from all these three species, *i.e.*, 48 chromosomes) should be fertile as well as the amphidiploid *undulata-paniculata*. The hybrids between *rustica* and the amphidiploid *paniculata-undulata* should be fertile too. This phylogenetic problem has such a direction of development. It is outlined here very roughly and will be given elsewhere in detail.

DONTCHO KOSTOFF.
Academy of Sciences of USSR,
Institute of Genetics,
Moscow,
May 23, 1936.

Cleistogamy in Sorghum.

CLEISTOGAMY occurs in many grasses. In wild species of *Hordeum* (Barley) cleistogamic forms have been noted. In cereals the occurrence of cleistogamy is very rare. The economic disabilities attendant on seed production under cleistogamic conditions militate against the common occurrence of cleistogamy in cereals; the more so in the case of sorghum in which the grains are naked and develop beyond the glume. In the wide collection of sorghums under study at the Millets Breeding Station, Coimbatore, two races, one Indian and another African, have been met with in which the flowers are cleistogamous. These races belong to the botanical group *Sorghum papyrascens*, Stapf., the very group in which erratic flowering,[1] vivipary,[2] and chlorophyll deficiencies[3] have been recorded. The long papery glumes and the degenerate lodicules have already been noted to be responsible for the erratic flowering.[1] In the cleistogamous forms, the earheads never give such evidences of flowering as the presence of stray emerged anthers and odd protruding stigmas. Such pedicelled spikelets as were antheriferous remained unopened. In spite of this the chaffy-looking heads did give a few viable grains. An examination was made of the cleistogamic forms in comparison with chasmogamic ones among the *papyrascens* group of sorghums. The following tabular statement brings out the points of contrast.

The cause of the cleistogamy will be evident from the accompanying table. In the cleistogamic forms the involucral glumes are big. The lower floral glume is very wide and clasps the upper floral glume (lemma) tightly. This clasp coupled with the degenerated scaly lodicules results in cleistogamy.

Sorghum papyrascens, *Stapf*. *Spikelet Measurements* (*Average of* 12).

	Chasmogamic form mm.	Cleistogamic form mm.
	L. B.	L. B.
Lower Involucral glume	7·0 × 4·0 (5·5 spread out)	9·5 × 4·5 (6·0 spread out)
Upper Involucral glume	6·7 × 3·6 (5·0 spread out)	9·5 × 3·5 (5·5 spread out)
Lower Floral glume	5·0 × 3·0 (4·0 spread out)	5·5 × 2·7 (4·2 spread out)
Upper Floral glume	4·5 × 3·5	4·5 × 3·5
Anthers	4·2 × 1·2	3·5 × 1·0
Filamental length	6·0 to10·0	4·0 to 6·0 (coiled)
Lodicules	2·3 × 1·5 × 1·0 (thickness)	1·1 × 0·6 × 0·4 (thickness)

Examinations made on spikelets at various hours of the night showed that between 3 and 5 a.m. there is a feeble endeavour on the part of the two involucral glumes to open out a bit, only to close up enclosing the clasped floral glumes with the anthers and ovary inside them. The smallness in the size of the anthers and the shortness in the length of the filaments (which become coiled) is noteworthy. In a dissected flower the anthers are stuck up against the stigmatic feathers and pollinate them after dehiscence (Fig. 1). In the spikelets in which the grains

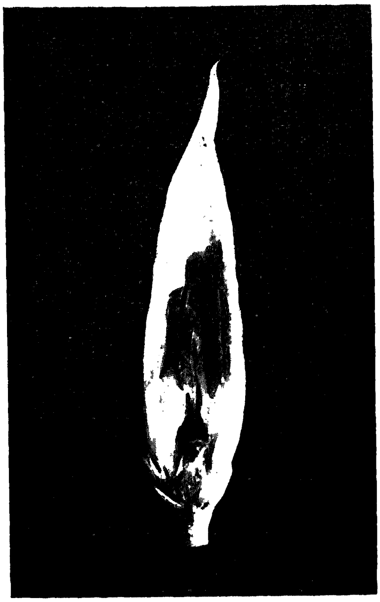

Fig. 1.

set, the shrivelled stigmas, anthers and filaments stuck up between the developed grain and the triangular niche above it, are easily noticeable (Fig. 2).

Earheads in which this cleistogamy occurred were analysed and compared with

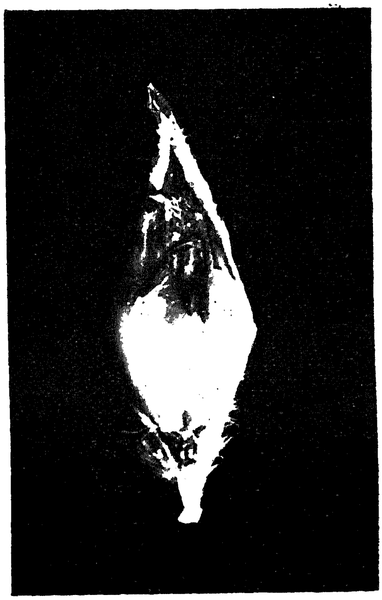

Fig. 2.

related chasmogamic lines and the following table brings out the points of contrast between the two.

Sorghum papyrascens, *Stapf*.

Earhead Analysis (*Average of* 6 *Heads*)

	Chasmogamic heads	Cleistogamic heads
Percentage of—		
1. Fertile sessile spikelets ..	59	50
2. Ill-developed seeds ($\frac{1}{3}$ weight of normal) ..	5	19
3. Viviparous seeds ..	9	15
4. Antheriferous pedicelled spikelets ..	0	17

In cleistogamic heads the relatively poorer seed setting is evident. The accentuated vivipary is noteworthy. Above all the remarkable activation under this abnormality of as many as 17 per cent. of the usually abortive pedicelled spikelets into antheriferous ones,[4] throws interesting evidence on the probability of these pedicelled spikelets having once had perfect flowers.

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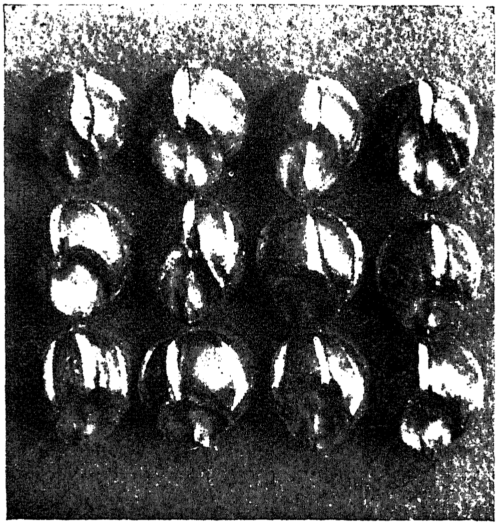
V. PANDURANGA RAO.
T. VENKATARAMANA REDDY.

Millets Breeding Station,
Coimbatore,
April 11, 1936.

1 *Jour. Indian Bot. Soc.*, 1936, **15**, 139-142.
2 *Curr. Sci.*, 1935, **3**, 617.
3 *Indian Jour. Agr. Sci*, 1932, **2**, 266.
4 *Indian Jour. Agr. Sci.*, 1931, **1**, 452.

Cracked Grains in Sorghum.



Cracked Grains in Sorghum.

IN Gramineæ, the rôle of the pericarp in the protection of the endosperm and the embryo is obvious. Any disturbance to this pericarp is deleterious to the seed. In Maize, Zapparoli[1] records the occurrence and inheritance of broken grains. In the grain sorghum which develops its naked grains outside the glumes, the importance of a sound and whole pericarp is obvious. At the Millets Breeding Station, Coimbatore, cracked grains in sorghum have been met with in half a dozen African races. They occurred in *Sorghum caffrorum*, Beauv., *S. caudatum*, Stapf., *S. rotundulum*, Stapf., and *S. guineense*, Stapf. In two races the cracking occurred in practically every grain of the earhead and in the others was found to be anything from 20 per cent. upward. Seasonal variations affected the degrees of expression. The cracked grains show best in the dough stage. Cracking commences with a longitudinal slit in the pericarp which deepens into a regular cleft with the rapid development of the grain, exposing the markedly noticeable white starch in the cleft. In purple pigmented varieties, these rents in the pericarp stimulate the usual run of pigment which gets deposited at the edges of the cleft and colours up the cracked areas. Cracking commences in the grains at the top of the panicle and covers the whole of it, in about a week's time. The cracks are very noticeable in round plumpy grains. They may be one, two, or three in number (see photo). They are disposed towards the embryo side of the grain and run roughly along the watermark lines clearly observable in some varieties. Cracking has so far been noted only in chalky grains[2] with a comparatively soft endosperm. In the flattish grains of *S. guineense* capped as they are with a partly corneous endosperm, the cracking is very irregular and erratic in disposition. In every one of these races, the markedly bold grain (big relatively to the grain size usually associated with the respective varieties), was a noticeable feature. In the earheads in which there were both cracked and uncracked grains, the average weight of cracked grains was about 6 to 7 per cent. more than the uncracked ones. Selections taken for cracking have bred true. The behaviour of this character in inheritance in crosses with normal grains is under study.

G. N. RANGASWAMI AYYANGAR.
V. PANDURANGA RAO.
T. VENKATARAMANA REDDY.

Millets Breeding Station,
Coimbatore,
April 12, 1936.

1 *Jour. Herd.*, 1925, **16**, 259-262.
2 *Indian Jour. Agr. Sci.*, 1934, **4**, 96-99.

Chromosome Numbers in Cymbopogon Species (*continued*).

IN a previous communication,[1] the chromosome numbers of five species were recorded. The numbers of the remaining South Indian

species and the numbers previously omitted are given in the present note.

Name of Species.	2n	n
Cymbopogon polyneuros, Stapf. ..	20	10[2]
C. Cæsius, Stapf. ..	22	11[2]
C. flexuosus, Wats. (Variety from Kallar) ..	20	10
C. Nardus, Tendle ..	20	..
C. Martini, Wats. ..	40	20
C. coloratus, Stapf. ..	40[2]	20
C. citratus, Stapf. ..	60	..

My thanks are due to Mr. K. Cherian Jacob of the Madras Herbarium, Agricultural Research Institute, Coimbatore, who kindly identified the different species and also supplied some of the material used in the present study.

C. N. BABU.

Oil Seeds Section,
Agricultural Research Institute,
Lawley Road P. O., Coimbatore,
May 19, 1936.

[1] *Curr. Sci.*, 1936, **4**, No. 10, 739-40.
[2] Already reported.

Some More Unrecorded Host-Plants of *Loranthus longiflorus*, Desr.

WITH reference to the articles published by Mr. G. D. Srivastava[1] and Messrs. Sayeed-uddin and Salam,[2] there may be added some more Host-Plants of *Loranthus longiflorus*, Desr. which have been found to occur in the neighbourhood of Patna. Fischer[3] has given a fairly comprehensive list of the various species of *Loranthus* and their host-plants as he found them in Southern India. There is no such record for the Northern part of the country. Various authors have made casual reference and mention of *Loranthus* and its hosts. If the botanists in various parts of the country could report the hosts and the parasites after proper identification, it could be summarised and an All-India list could easily be prepared which will certainly throw more light to understand this baffling parasite and its mode of parasitism.

Haines[4] has recorded four species of *Loranthus* in the province of Bihar and Orissa, *viz.*, *L. longiflorus*, *L. globosus*, *L. scurrula* and *L. cordifolius*. In the month of February ripe berries of *L. longiflorus* were collected. The skin was removed and they were fixed by their viscin on the stem of various plants. The seeds germinated in about a month, sending out a pair of leaves and fixing firmly to the host by the haustoria. Various plants were tried as hosts without any special discrimination. The dry wind which started and continued for a week during the beginning of March, did effect most seeds, but many seeds germinated and took hold of their hosts in the usual way. In case of *Ficus glomerata* and *Ficus carica*, all the seeds germinated successfully and seemed to flourish very well. It may be due to the juicy and milky nature of the bark which allowed enough facilities to effect the hold on the host (Fig. 1).

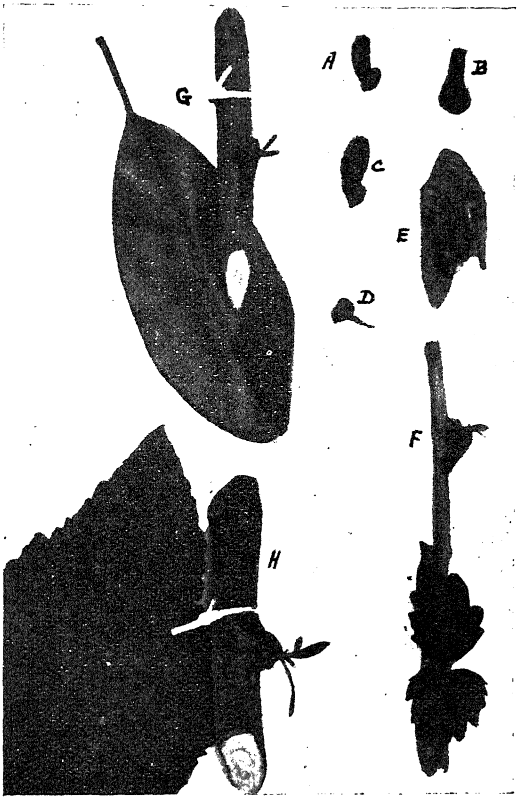


Fig. 1.

A—H.—Showing the various stages in the germination of the seeds of *L. longiflorus* on different hosts.

The hosts were recorded at various times of the year but the species of the parasite was ascertained during the flowering season. Round about Patna, only *L. longiflorus* abounds. Evidently there appear no specialisation of hosts with this parasite, it seems that there is more or less a chance of transfer of the seeds at the right place which is helped by climatic conditions. Of course the shedding of the bark plays an

important part as it was noticed in the case of Eucalyptus. The seeds were put on the tree after making a slight incision in the bark in the beginning of March. They started germinating, but the tree completely shed its bark from top to bottom in the end of the month. Consequently the seeds were thrown off.

It was also noticed that seeds which were put on the western side of the stem in most cases did not survive the hot winds blowing from west to east, while a marked difference was noticed in the seeds on the eastern side which got some protection from these scorching winds.

From the long list given by Fischer,[3] one can see the heterogeneous types of hosts. One is forced to conclude the laxity of this parasite in selecting its hosts, which are again governed by other factors, *e.g.*, climatic and chance.

The following hosts of *Loranthus longiflorus*, Desr. have been recorded in Patna so far. The first 15, to my knowledge, have not been recorded so far. Mango and Shisham seem to be very badly infested with this parasite. *Aegle Marmelos* and *Terminalia Catappa* have been reported as host plants of *Loranthus* from the Royal Botanical Garden in Calcutta by Scott, but the species of the parasite is not mentioned. Similarly, *Rosa* species is reported from Ootacamund Botanic Gardens by Biddie without the specific parasite.

Thanks are due to Prof. S. S. Choudhury for drawing my attention to the parasite on *Sesbania ægyptica*, var. *bicolor* in the College Botanical Garden.

(1) *Aegle Marmelos*, (2) *Ficus infectoria*, (3) *Swietenia macrophylla*, (4) *Cassia fistula*, (5) *Thevitia neirifolia*, (6) *Sesbania ægyptica*, var. *bicolor*, (7) *Morus indica*, (8) *Codiæum varicgatum*....'Croton', (9) *Grevillea robusta*, (10) *Cordia myxa*, (11) *Terminalia Catappa*, (12) *Cedrela Toona*, (13) *Rosa* sp., (14) *Bauhinia variegata*, (15) *Premna mucronata*, (16) *Wrightia tomentosa*, (17) *Mangifera indica*, (18) *Melia azedarach*, (19) *Psidium guayava*, (20) *Ficus religiosa*, (21) *Dalbergia sisso*, (22) *Albizzia labbek*, (23) *Callistemon linearis*, (24) *Casuarina equisetifolia*, (25) *Acacia auriculæformis*, (26) *Tectona grandis*, (27) *Bombax malabaricum*, (28) *Punica granatum*, (29) *Pongamia glabra*.

From the list given above one can easily see that a large number of these hosts have not yet been recorded. Nos. 16 to 29 have been found to occur here, but they have been recorded by various observers at other places in India.

R. C. LACY.

Biology Department,
P. W. Medical College,
Patna, Bihar,
May 14, 1936.

[1] Srivastava, G. D., *Curr. Sci.*, 1935, **4**, 106.
[2] Sayeed-uddin and Salam, *Curr. Sci.*, 1935, **4**, 162.
[3] Fischer, C. E. C., *Rec. Bot. Survey of India*, 1926, **11**, No. 1.
[4] Haines, H. H., *Bot. of B. & O.*, Part V, 119.

English as the Common Language.

ONLY recently have I seen your article "English as the Common Language of India" in the November 1935 issue of your *Journal*[1] and note that in it there is no reference to the general question of an International auxiliary language.

Many individuals and institutions have given much thought to this problem, but most agree that a so-called natural language is out of the question.

Amongst the activities in this field in English-speaking countries the following may be mentioned.

The American Philosophical Society appointed a Committee whose report was published in their *Proceedings*[2] and reproduced in *Nature*.[3]

A British Association Committee submitted a report published in 1921 (*B. A. Report*, pp. 390-407) and stated "an invented language is best. Esperanto and Ido are suitable: but the Committee is not prepared to decide between the two".

In 1918 the (British) Prime Minister's Committee on Modern Languages recommended....that a Committee be appointed to inquire into the potentialities of artificial languages and of the desirability of encouraging the development and use of one (quoted in *B. A. Report* referred to above).

The International Auxiliary Language Association founded some years ago in New York is still carrying on research work.

'*Nature*' has more than once voiced the desirability of such a language. In its number for October 16, 1926,[4] it states that "of the artificial languages now current, only Esperanto, its off-shoot Ido and Interlingua (Latin without inflexions) are of serious importance". To these perhaps may be added now "Novial" of Prof. Jespersen. Latin with inflexions is supported in Germany by "Societas latina"; in the U. S. by Prof.

Roland G. Kent of the University of Pennsylvania and by others.

About Interlingua Prof. F. G. Donnan, in his lecture at the Royal Institution of Great Britain, published in its *Proceedings*,[5] states: "the man who has defined most clearly the Neo-Latin principle and who has not only worked the hardest in this field, but also grouped and organised many isolated workers of kindred views and affiliations is (the late) Dr. G. Peano..... Following the indication given by Leibniz, Peano built on an exclusive Neo-Latin basis so far as the main vocabulary is concerned, though modern words acquiring international usage may be accepted. Partly as the result of Leibniz's views, and partly on the basis of his own reasoning, he has eliminated from grammar formal gender, declension, number and even conjugation of the verb.. the result is his Latino sine flexione" or Interlingua. According to the statement of Prof. J. L. Gerig of Columbia University, New York, Interlingua is the only one (of the International languages) that is making any real headway (*Americana Annual*, 1933: art. Philology).

Of all countries it would seem that India with so many very important vernaculars should have a large number of people interested in the problem of an International auxiliary language. In connection with the use of English there is a very interesting article by Kilne O. Moe in *Mid-Pacific Magazine*[6]; in it is stated that the "Filipino English is in a class by itself....evolved but of many painful attempts to find a common medium". The author asks the question "Will the English language survive in the Philippines?" and the answer is not an unqualified yes.

Information about Interlingua may be had from Prof. N. Mastropaolo, Editor of *Schola et vita*,* organ of the Academia pro-Interlingua, which is carrying on its work from the time of Volapuk. It may be added that a very extensive Interlingua-English and English-Interlingua vocabulary, larger perhaps than any of the other International languages, is very nearly completed, and it is hoped to find funds for its printing.

A. FANTI.

c/o National Bureau of Standards,
Washington, D. C., U.S.A.,
May 10, 1936.

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[1] *Curr. Sci.*, 1935, **4**, 296.
[2] 1888, **25**.
[3] *Nature*, **38**, 351-355.
[4] *Nature*, 1926, **118**, 543.
[5] 1920-22, **23**, 546.
[6] *Mid-Pacific Magazine* for Jan.-March, 1936, pp. 28-31.

* Address of "Schola et vita": Viale Berengario, 19, Milano, Italy.

A Preliminary Survey of Marine Boring Organisms in Cochin Harbour.—A Correction.

LAST October I sent some specimens of Sphæromidæ to the British Museum for identification, which were determined as *Sphæroma terebrans* Bate and *S. annandalei* Stebbing by Dr. I. Gordon, tentatively. Some of the material was sent to Dr. Monod of Paris, who is the chief authority in this group of Isopods. I have recently received a report of Dr. Monod's identifications which necessitate a correction in my paper on Marine Borers in Cochin Harbour.[1]

Dr. Monod is of opinion that the material must be referred to *Sphæroma vastator* Sp. Bate. He would retain *S. vastator* as distinct from *S. terebrans*, the former an Indian Ocean (and probably South African), the other an Atlantic, form. He also says, moreover, that as to *S. annandalei* he cannot see how it differs from *S. vastator*[2]; and would find it exceedingly difficult to separate the two.

EILEEN WHITEHEAD ERLANSON.

Madras,
June 9, 1936.

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[1] *Curr. Sci.*, 1936, **4**, 726-732.

[2] Extract from a personal communication from Dr. Gordon.

Research Notes.

New Data on Isotopes.

SINCE the binding energies of nuclei can be estimated from their mass defects, the importance of accurate values of the atomic weights of the isotopes of elements need not be laboured. Great interest therefore attaches to the new work of Aston with his improved new mass-spectrograph. His values for the atomic weights of the proton, the neutron, helium and carbon have already been quoted in these columns. In *Nature*, 1936, **137**, 613, he has reported the results of new measurements carried out by him. Great accuracy has been obtained by comparing pairs of particles of almost the same mass—the so-called doublets such as N, CH_2; F, HDO; Ne, D_2O etc. The following are his results:—

Symbol	Packing Fraction	Isotopic Weight
^{10}B	16·1	10·0161 ± 0·0003
^{14}N	5·28	14·0073 ± 0·0005
^{19}F	2·36	19·0045 ± 0·0006
^{20}Ne	−0·70	19·9986 ± 0·0006
^{27}Al	−3·3	26·9909 }
^{28}Si	−5·0	27·9860 }
^{29}Si	−4·7	28·9864 ± 0·0008
^{40}A	−6·15	39·9754 ± 0·0014

He has also revised the isotopic constitution which he had previously given in the case of a few elements. These are:

Cd :	Mass numbers	106	108	110	111	112	113	114	116		
	Abundance	1·5	1·0	15·6	15·2	22·0	14·7	24·0	6·0		
Sn :	Mass numbers	112	114	115	116	117	118	119	120	122	124
	Abundance	1·1	0·8	0·4	15·5	9·1	22·5	9·8	28·5	5·5	6·8
Pb :	Mass numbers	204	206	207	208						
	Abundance	1·0	28·3	20·1	50·1						

The other previously given isotopes of Pb are regarded as doubtful.

He considers that Fe 58 and Ni 64 found by Zeeman and de Gier by the parabola method no doubt exist, whereas Ni 61 observed by them seems to present a conflict with his own results. He also regards that Nd 148 and 150 recorded by Dempster are real isotopes, in which case, as he points out, the discrepancy between the chemical atomic weight and the mass spectrograph value may disappear.

T. S. S.

Thixotropic Gels.

GELS which can be converted into sols by applying a suitable mechanical stress, *e.g.*, by shaking, and set to gels again at a definite rate when the stress is removed are known as thixotropic gels. The actual transition in such a system from sol to gel or *vice versa* is not in general accompanied by a change in volume, and the average distance between the constituent particles must therefore be the same in the sol and the gel. Under the circumstances it is interesting to enquire how the rigidity has developed in a previously fluid sol. A widely accepted explanation is that the particles in the gel are surrounded by thick envelopes of oriented water molecules or "lyospheres", and that these envelopes are destroyed by shaking, and reform on allowing to stand. When these spheres are large enough to make contact with each other the sol becomes rigid. Such an explanation is however not very convincing, and in the May number of the *Proceedings of the Royal Society*, J. L. Russel and E. K. Rideal have advanced an alternative theory that thixotropic gelation is due to oriented coagulation of the highly dispersed anisotropic material which is usually contained in such gel materials. In such a sol system on the gradual addition of an electrolyte a point will be reached where adhesion will occur when two particles come together at a particular orientation with respect to each other, but not if they collide in any other way. Any stress which tends to destroy the orientation destroys the structure. With higher electrolyte concentrations, random coagulation will occur and irregular flocks will be formed.

Eloxal and the Seo Photo Process.

DR. ALEXANDER JENNY describes in *Forschungen und Fortschritte* (12, No. 5, 69) the new SEO (Siemens-Electro-Oxidation) process in Photography. The process consists essentially in covering a plate of Aluminium with a surface film of its oxide by oxidising the metal electrolytically in an acid medium. The thickness of the oxide layer is of the order of 2 to 20 μ.

(*Continued on page 889.*)

SUPPLEMENT TO "CURRENT SCIENCE".

The Mechanism of Enzyme Action.

By Professor A. Fodor.

(*The Hebrew University, Jerusalem.*)

1. Introduction.

THE first to assert the momentous law of the reign of a catalytic power in nature, whereby complicated chemical processes, for whose realisation the chemist requires powerful reagents and high temperatures, become easily possible under the mild conditions prevailing in plant and animal organisms, was Berzelius in his famous *Text-Book of Chemistry*. At an early date the action of this catalytic power was traced to the Ferments, or Enzymes as they were termed later. The action was specific,—given effects being obtained only with given fractions of secretions or organ extracts and only under definite conditions of medium. Biochemists were thus led to postulate the existence of a multitude of catalytic "substances," whose chemical action was well known, but whose chemical nature remained a mystery. The specificity of the enzymes was set forth most sharply by the investigations of Emil Fischer on stereoisomeric substrates, investigations which led this researcher to draw his famous analogy of "key and lock".

As might be expected, these actions have been an unfailing source of stimulation for the researcher, and have ever spurred him on in his efforts to determine the chemical structure of the mysterious substances causing them. As yet, however, the aim has not been attained with enzymes. R. Willstätter, H. v. Euler and their collaborators tried for many years to prepare pure enzymes, but only succeeded in enhancing the activity of their preparations by freeing the total mass of cell and tissue ingredients from those parts which, in their opinion, contained little or no enzymic substance. But the residue obtained by them was itself nothing else again than a further mass of cell ingredients united with active substance, the chemical nature of which still remained as unexplicable as ever.

It is very difficult under these circumstances to speak of a purification of the enzymes. It is an open question whether the above mentioned concentration process really constitutes a true purification at all. By the expression purification the chemist understands the liberation of a compound (A) from other compounds (B, C . .) which generally stand in no direct relation to it. No such purification can be reported for enzymes. Willstätter, by the ingenious method he has developed, abstracts from the total number of carriers, as the mass charged with active substance may be termed, only those carriers whose activity is most manifest. The other carriers, however heavily they may be charged with active substance, are neglected by this method. The essence of the Willstätter method is the autolytic breakdown of the original native carriers, which being mainly colloidal do not, as we shall see, reveal their true degree of charge with active substance, into low derivatives which freely manifest their association with the active principle and hence also their function as carriers.

Before drawing such a conclusion, it was necessary for us to prove that different carriers variously enhance or depress the activity of the active substance (the very nature of which is still a mystery to us), even as a definite quantity of electricity charges variously bodies of different dielectrical properties which thus act as a real determinant of the "electrical activity".

Carriers which manifest the activity of their active substance we shall term zymophoric. The degree in which the activity

of the active substance in respect of a given substrate is made manifest by the zymophore corresponds to the degree of zymolability (or inversely to the degree of zymostability) of the zymophore. Zymolability is merely a qualitative and relative concept, however. In reality it is revealed to us only by the relative ease with which the active substance (zy. s.) is transmitted from the carrier (C) to the substrate, as well as by the effect of this transmission process.

$$C \longleftrightarrow zy.s. + \text{substrate} \rightarrow C + \text{substrate} \longleftrightarrow zy.s.$$

Assuming that the substrate on association with active substance undergoes chemical alteration (hydrolysis, decomposition, etc.) at an infinitely great velocity, it must be concluded that in kinetic experiments it is this transmission effect which is really measured. If the measurements are carried out in the first phase of the enzymatic action upon the substrate, before the formation of the cleavage end products has so far advanced that these products themselves become significant as carriers of active substance, the quantity of the substrate transformed during this period may be taken as a measure of the enzymatic activity, *i.e.*, of the transmission effect. In respect of any given enzyme extract prepared under exact and constant conditions and allowed to act either upon several substrates present in equivalent amounts in the same medium, or upon the same substrate under varying conditions of medium, the presence of different substances, for example, the amount of substrate transformed during the first phase (t) of the reaction forms a valid measure for comparisons of enzymatic activity. In no case, however, are the *actual* "enzyme units" or "enzyme quantities" determined by kinetical measurements. What is really measured is the transmission effect of assumed enzyme quantities, but not as is the case in ordinary kinetic experiments, an effect which is governed solely by the actual concentration or quantity of the reacting compound. To be sure, the very nature of this transmission effect is not yet definitely known. Enzymic activity is only the outward manifestation. The transmission itself probably involves a distribution of active substance between the carrier and the substrate, a distribution dependent for its realisation upon the occurrence of a definite manner of contact betwen the two bodies. The frequency of this contact, moreover, depends upon the nature of the carrier involved. This view thus assumes that a chemical and physical, constitutional and perhaps configurative, relationship underlies the mutual association of substrate and carrier. This assumption also provides the explanation of that other cardinal feature of enzymic action: its specificity.

Though the assumption that the velocity of a given reaction is determined by the frequency of the collisions of the reacting compounds and that this frequency in turn is proportional to their concentration is quite permissible in ordinary chemodynamical considerations, this assumption is not justified in the case of enzyme action. In this case the collisions must be of quite a definite nature, if they are to result in a manifestation of the above mentioned "chemical and physical relationship" between carrier and substrate. It is necessary for the colliding bodies to form a definite space pattern which is the prerequisite of their combination. The frequency of occurrence of appropriate collisions, *i.e.*, collisions in which the participating bodies assume the right position in space, is governed by a certain degree of probability and is increased if the chemical structure of the colliding bodies causes them to tend to "catch" each other. Only when these suitable collisions occur, is enzymic activity (with the transformation of activated substrate proceeding at infinite velocity) manifested.

We regard as zymophoric only such carriers which can enter into the above mentioned relationship with the substrate. Their zymolability is the greater, according as their chemical structure permits of a greater frequency of "appropriate" collisions, according as, that is, the "attraction" between the two partners is the stronger.

This is the interpretation which should be placed upon the fact that in peptidase action glycocoll behaves as a non-zymophoric carrier whose presence hinders the hydrolysis of the dipeptids. For higher polypeptid substrates, on the other hand, glycocoll appears to be an appropriate carrier, and its addition increases the rate

of the hydrolytic cleavage of such a substrate. Conversely certain proteins and their derivatives have been found to be fit carriers for the cleavage of dipeptids but less fit for higher peptids.

These observations may be brought to a head under a simple formula that proteins and their high derivatives enter more easily into the above described relationship with low protein derivatives such as amino acids or dipeptids than with higher protein derivatives. The low protein derivatives moreover evidently possess no affinity for each other which could bring about the association of carrier and substrate. The higher products are thus seen to constitute the best carriers for dipeptids, the amino acids for higher polypeptid substrates. The fact that the higher derivatives seem to exercise almost no attraction for each other, is probably due more to the large, hence cumbersome size of their molecules, which lowers the frequency of "appropriate collisions", than to any lack of affinity.

Still a few words more on the chemical nature of the carriers. It is a striking fact that in peptidase action only substances whose chemical nature is much akin to that of the substrate, *i.e.*, substances of polypeptid structure, act as carriers. This is not a mere coincidence in our opinion but rather a significant peculiarity which is inherent in the nature of living matter. As an ingredient of the living plasma, a protein is charged from the very beginning with a definite quantity of active substance (zy. s.) which, on the decomposition of the protein to lower derivatives, is transmitted (in the sense defined) to the latter. It may be laid down as one of the main criterions of the substance of the living plasma that they are equipped with the catalytic agents of their own decomposition, the products of which beginning with the higher and lower intermediate derivatives and ending with the lowest final products, serve as carriers of the active substance which is successively transmitted to carriers of various zymolability and is thus enabled to fulfil the various biological functions. This is true not only of proteins but also of other cell ingredients of high molecular structure. The seed which contains protein, starch, lipins, etc., as reserve substances is at the same time thus provided with all the enzyme systems necessary for the decomposition of the substances under the condition of germination. Moisture and the proper temperature act upon these systems as activators. In this way the ingredients of the living substance provide above for the implements of their dissimilatory decomposition, acting themselves as the carriers of these implements and transmitting them also to decomposition products which in turn act as new carriers. In the light of these considerations, the chemical kinship which is generally displayed by the carriers of a given enzyme system, such as polypeptidase, and its substrate no longer appears astonishing. All are equally decomposition products of the same mother substance.

The existence of a multiplicity of carriers in the enzyme action, and the possibility of a change of carriers, whereby the appearance of new enzyme specificities may be explained, are the fundamental ideas of the conception advanced above. In view of the fact that the isolation of pure enzymes has not met with success despite manyfold attempts and that at every trial the researchers only succeeded in isolating new carriers, it seems plausible to suppose that enzyme systems are in essence but multitudes of carriers charged with as yet unknown active principles, and that specific action is the result of chemical adaptation in varying degrees of completeness between carrier and substrate. The adaptation is the greater, the greater the specificity, the latter being the measure of the possibility of combination, either between numerous kindred substrates and some highly specialised, configuratively adapted and irreplaceable carrier, as is the case with α-glucosidase. We have found no legitimate reason however for assuming as several researchers (Willstätter, v. Euler, etc.) have done that there are as many active substances as there are specific actions in a given group of kindred substrates, that in other words several "dipeptidases" and a multitude of polypeptidases exist. The experiments mentioned in Part 2 of this paper seem to show the relative truth of our view-point.

2. Some Proofs of the Multiple Character and Interchangeable Nature of the Carriers in Peptidase Systems.

In this section some experimental results are described which are only comprehensible

on the assumption that there exists a multiple of carriers for one and the same enzyme action, *e.g.*, the hydrolytic breakdown of polypeptids, that the appropriate individual carriers are mutually interchangeable, and that by the interchange the system's activity becomes altered.

The hydrolytic cleavage of polypeptids, both dipeptids and higher peptids (beginning with tripeptids and proceeding to higher forms) can be effected both by peptidase—wealthy yeast extracts and by pancreas extracts, or pancreatin preparates, *i.e.*, by the dried substance of the pancreatic gland. It hardly needs to be mentioned that these extracts also act on peptons which substances are known to be a mixture of higher polypeptids.

It was found (Abderhalden and Fodor, 1916) that fresh-water extracts of yeast on standing one or two days at room temperature, show a strikingly increased activity in respect of many dipeptids, but that this increased activity sharply drops again after five or six days more of preservation. The cause of this variation in activity which was invariably found to occur in extracts of dried Munchen yeast, could only be traced later to an autolytic breakdown by virtue of which the "active substance" of the polypeptidase system is transmitted from its native carrier—the yeast phospho-protein—to the products of this carrier's autolytic breakdown. Since the higher autolytic breakdown products (carriers K) which are appropriate, *i.e.*, zymolabile carriers for the splitting of dipeptids are formed first, the ability of the extracts to breakdown dipeptids at first increases. When in more advanced stage of autolysis however products of low molecular size (carriers X) and zymostable, as far as the hydrolysis of dipeptids is concerned, begin to predominate and the same activity falls. As has already been pointed out, however, we only arrived at this explanation later.

It was afterwards shown (Fodor, 1920-1922) that the original carrier of peptidase action in yeast extracts is phospho-protein a substance which these extracts contain in abundance. If the fresh maceration juices of yeast are precipitated with dilute hydrochloric acid, the protein coagulates in so delicate a form that, after filtration and cleansing with water, it may be redispersed by stirring with the latter forming a persistent suspension which exhibits all the characteristic features of a grossly dispersed colloidal system. The ultramicroscopical picture of the suspension shows extensive aggregate formation with but few single particles in a state of Brownian movement. Such an enzyme sol has been found to show under optimum conditions of concentration, temperature and pH a low but definite activity in respect of dipeptids. On carefully adding dilute sodium hydroxide to the sol, its activity increases, simultaneously, the ultramicroscopic picture obtained discloses a great increase in the degree of dispersion with single particles in strong Brownian motion, beginning to predominate over the aggregated forms. If however the addition of sodium hydroxide is carried too far, the field becomes empty, due to the formation of invisible alkali protein, and simultaneously the zymatic activity of the sol falls.

In this way was the existence of a definite carrier of enzymic substance proven, and the dependence of this enzyme's activity upon the physical state, *i.e.*, the degree of dispersion of the carrier demonstrated. In the case of a colloidal carrier, such as for example phospho-protein, an optimal degree of hydration is necessary for the manifestation of maximal degree of activity.

We were unable to decide at the outset whether the phospho-protein merely acts as a carrier of the peptidase action in the yeast and pancreas extracts (Fodor, 1922) or is itself the active substance or the enzyme. This question might have remained unanswered moreover had we not by a stroke of good luck found that glycocoll was a suitable elution agent for the kaolin adsorbate of yeast extract. All other elution means tried, aminoacids, other than glycocoll included, were fruitless. Stimulated by the adsorption and elution method developed by Willstätter, we (Fodor, Bernfeld and Schoenfeld, 1925) treated yeast macerates with a suitable form of kaolin which adsorbed their protein content. The adsorbate, after having been thoroughly washed, could be eluted with glycocoll. The eluate (A) proved to be active in respect of both dipeptids and peptons, particularly the latter. It was found to be nearly free of protein (with Esbach reagent, a very slight clouding resulted) but gave several of the colour

reactions, that with glyoxylic acid for example, and must therefore have contained some protein derivatives. Under aseptic conditions we were able to preserve this eluate without any change in its activity several months. An attempt to carry out a new kaolin adsorption and subsequent glycocoll elution did not succeed. The kaolin adsorbate of eluate A was itself active but admitted of no elution with glycocoll. At this juncture we felt justified in setting up the following scheme as representation of these adsorption and elution processes:

First adsorption : Protein $\longleftrightarrow$ zy. s. + Kaolin $\longrightarrow$

$\longrightarrow$ Kaolin $\longleftrightarrow$ Protein $\longleftrightarrow$ zy. s. ;

First elution : Kaolin $\longleftrightarrow$ Protein $\longleftrightarrow$ zy. s. +

Glycocoll $\longrightarrow$ Glycocoll $\longleftrightarrow$ zy. s.

Second adsorbtion : Glycocoll $\longleftrightarrow$ zy. s. + Kaolin $\longrightarrow$

$\longrightarrow$ Kaolin $\longleftrightarrow$ zy. s.

Second elution : Kaolin $\longleftrightarrow$ zy. s. + Glycocoll $\longrightarrow$

$\longrightarrow$ no elution

The elution process is only successful if the active material (zy.s.) is directly linked to the protein and not to the adsorbent.

At the later date (Fodor and Frankenthal, 1930, 1931), when we carried out the adsorption on kaolin of phospho-protein coagulated from yeast extracts by dilute acids, and eluted the adsorbate with glycocoll, we obtained an eluate B which was active in respect of the tripeptid leucyl-glycyl-glycine, but inactive in respect of the dipeptid leucyl-glycine.

Evidently, a carrier of category K (see above) which promotes the splitting of the dipeptid, must be assumed as present in eluate A. Since such a carrier is lacking in the much purer eluate B the latter is unable to hydrolyse the dipeptid.

Starting from this assumption we were led to the idea of attempting to bring about the activation of the eluate B in respect of the dipeptid by the addition of a carrier of the category K. With this aim in view we permitted yeast to undergo brief autolysis in the presence of acetic ether so as to obtain an increased yield of the high protein derivatives (K). When this operation was completed, an ultrafiltrate of the autolysate was prepared in order to separate the original unaltered protein from their newly formed K-derivatives. When the clear ultrafiltrate, which exhibited no enzymic activity whatsoever was added to eluate B, the latter was activated, splitting fully 32% of all the leucyl-glycine present in the course of 21 hours at the temperature of 25° C. In this way therefore eluate B aquired a capacity it had formerly lacked. The experiments thus furnished proof that for the cleavage of the dipeptid, glycocoll is an *inappropriate carrier of the active* substance of peptidase system. The dipeptid can only be split if carriers K, such as are contained in fresh yeast autolysates, are present.

It was shown by analogous experiments that pancreas extracts totally inactive in respect of glycyl-leucine but active in respect of glycyl-leucyl-leucine acquire an activity in respect of the dipeptid after an induction period of about 3–4 hours (37°) which is necessary for autolysis. It would be demonstrated, moreover, that the curve of the dipeptid hydrolysis followed the course of an autocatalytic process. This result admitted of no further doubt concerning the truth of the conclusion that the first products of the autolysis are the activators of the dipeptid hydrolysis. Moreover this conclusion furnished us with a convincing explanation of the results of our experiments of 1916 (s. above) which showed that the ability of yeast extracts to cleave dipeptids (and also peptons) increases with preservation.

This increase is evidently connected with an autolytic process wherein apparently not only carriers K but also products X of a further degree of breakdown are formed. For this reason apparently the ability to split peptons is also increased (even by 55%) on preservation under these conditions, *viz.*, for a period of three days at room temperature (Fodor and R. Cohn, 1928).

Some proof must still be furnished that the deep breakdown products (X) of the protein, among them amino acids, increase the activity in respect of higher peptids (and peptons) but not in respect of dipeptids. Experiments with this aim in view were carried out with maceration juices of pancreatic glands (Schoenfeld-Reiner, 1930).

The results showed that on the addition of pepton hydrolysates, rich in X carriers, to a mixture of this pepton and the macerate, the pepton cleavage was augmented, but that of the dipeptid decreased. Apparently the cleavage of dipeptids is obtained by carrier X.

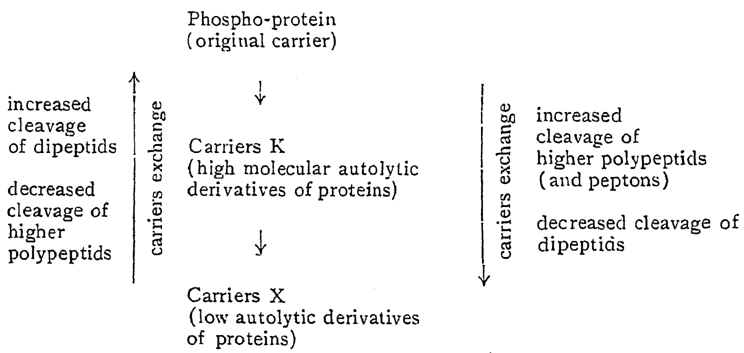
On the other hand, it could be demonstrated that pancreatin macerates which were deprived of the greater part of their carriers X content by a short dialysis, suffered a loss of activity in respect of peptones, but gained in activity in respect of dipeptids.

We are clearly led to expect from these results that the addition of amino acids which represent the extreme of the carrier X type, to a yeast extract would cause an activation of the latter in respect of peptones. We actually succeeded moreover repeatedly to demonstrate this activation (Fodor, 1928, Fodor and R. Cohn, 1928). Especially striking results were obtained with fresh maceration-juices relatively poor in carriers X. Extracts which were not so fresh and contained relatively greater amounts of carriers X and K owing to the advanced state of the autolysis, exhibited a lesser degree of activation in respect of peptones on the addition of the amino acids.

On the basis of the experimental results described above, we felt justified in proposing the following carrier scheme (Scheme I).

The explanation advanced by the Willstätter school ascribes these activation and depression effects to the removal and appearance respectively of "detaining bodies" (Hemmungskorper), but this is merely a tautological circumscription of facts, and no true explanation. We only possess this latter when we have comprehended that the "detaining bodies" are nothing else than zymostable carriers. Their exchange for zymolabile ones brings an activation in its wake; exchange *vice versa*—a depression. The active substance is distributed, according to this view-point, between its original zymostable carriers and new zymolabile ones, such as those that are contained in various autolysates for example, or such substances as we added directly. A depression in activity signifies an exchange of one carrier for another with a contrary effect. The new carriers formed during the autolysis of protein might also be regarded as intermediating carriers (Scheme II).

Scheme I.



Scheme II.

(*a*) Carrier X $\longleftrightarrow$ zy. s. + dipeptid $\xrightarrow{\text{by a slow transmission}}$ dipeptid $\longleftrightarrow$ zy. s.

(*b*) Carrier X $\longleftrightarrow$ zy. s. + carrier K $\xrightarrow{\text{by a rapid transmission}}$ carrier K $\longleftrightarrow$ zy. s.

Carrier K $\longleftrightarrow$ zy. s. + dipeptid $\xrightarrow{\text{by an accelerated transmission}}$ dipeptid $\longleftrightarrow$ zy. s.

It is evident that the relative quantities of zymostable and zymolabile carriers present will have a significant influence upon the effect of the transmission of the "active substance" to a given substrate and consequently also upon the zymotic activity in respect of the latter.

It may also be deduced from this statement that the constancy of an enzyme system is dependent upon the nature of the carriers of the active substance. As long as the carrier is a colloid, in which state as a rule, it is subject to incessant change, no constancy of activity can be expected. If active substance is transmitted to a protein derivative carrier which itself suffers cleavage as a result of this transmission, the breakdown will produce new carriers that will compete with the substrate, by acting themselves as substrates. In this competition however the substrate proper, owing to its greater concentration, gains the lion's share of active substance. Nevertheless it is a significant fact that such a system undergoes perpetual changes in activity, changes which are already revealed in the self-alteration of enzyme extracts and which researchers take into account by setting up parallel controls.

True constancy can only be expected where the carrier is not subject to changes of the nature mentioned above. This condition was fulfilled for example in our glycocoll eluates. The experimental verification of this fact provides additional proof that the eluting substance, *i.e.*, the glycocoll, is itself the actual carrier of active substance in the eluates.

3. Theoretical Considerations.

The following paragraphs deal with the nature of the zymoactive substance. This is still as has been pointed out above, a mystery to us. In discussing its chemistry therefore we enter a domain of pure hypothesis.

Our claim that zymoactive substance (zy. s.) distributes itself between the substrate and one or several carriers contains the implication that zy. s. possesses an affinity both for all the different but chemically kindred carriers and for the substrate which, as we have shown, also ranks among these chemical relatives.

This conception involves a further assumption. The chemical constitution of the zymoactive substance must admit a combination both with the multitude of carrier and with the substrate which itself acts in this case as a carrier. Consequently it was concluded that zymoactive substance possesses a common affinity for all these carriers, substrate included. But granting this, the existence of at least as many zymoactive substances as there are protoplasmic carriers of fundamentally different chemical constitution must also be granted. For it is inconceivable that the same active substance enters into combination both with the totality of proteins and protein derivatives and with such a substance as starch for example or other cell and tissue constituents.

We are thus led to conclude that the ground substances of the plasma are equipped above with zymoactive substances which are closely attuned to them chemically. When the ground substances are broken down into breakdown products of a kindred chemical constitution, the zymoactive substances become transmitted to them (see above).

These conclusions follow from our main premises. It follows further from the investigations of many researchers on enzymes that the active principle is impermeable to dialytic membranes and must therefore be in a colloidal state. Where the dialysis brings about the inactivation of the enzyme system, its activity can, as a rule, be restored by the re-addition of the dialysate to the dialysed solution even though both these fractions were themselves inactive. It may be concluded therefore that the active principle of the system does not diffuse through the membrane and that inactivation by dialysis is merely due to the removal of permeable activators.

On the other hand, we are compelled to conclude from the experimental results of several researchers that the separation or isolation of the active substance is an impossibility, and that its connection with a carrier is necessary for the manifestation of activity. When we attempt to attain the active material in pure form, all we ultimately get is inactive chemical substance. The zy. s., whose quantity is extremely minute, is lost during the purification procedure in the mass of purifying reagents.

It seems right therefore to conclude that the colloidal active material depends for its existence on its connection with a carrier or substrate, *i.e.*, that the activity is only preserved in connection with the latter, and that separation brings inactivation in its wake, probably as a result of some change in colloidal state, such as coagulation. It is a commonplace experience of the colloidal chemist that substances which in a high degree of dispersion possesses enormous surfaces and fill correspondingly great volumes, are almost invisible to the naked eye and hardly measurable by weight after coagulation.

Consistent with our view that the active material is a colloid of high disperse degree which is linked to carriers and preserves its dispersion only as long as this linkage endures, we may go a step further and concede that the linkage to the carrier is to be ascribed to a compensation of the great surface energy, and that liberation from the carriers invariably involves the loss of this compensation and hence a coagulation. The carrier thus functions as a protective colloid: it preserves the colloidal state of the substance which is linked to it.

It is permissible for us to draw still another conclusion of a colloidal kind, *viz.*, that a partial annulment of the surface energy of the active material can be attained by a change of carrier. If we assume, as indeed we do below, that a parallelism exists between the surface energy and the activity, we may regard as zymophoric only such carriers as allow to maintain the high energy state; carriers which bring about its decrease may not be regarded as zymophores. On the other hand, the measure of zymolability is largely dependent upon the efficiency with which diminution of the surface energy maintained by a given carrier, is effected by the combination of this carrier with the substrate. According to energetical principles, the surface energy liberated by this combination must manifest itself as thermal, electrical or chemical activity (depending upon the conditions prevailing in the system under consideration), and hence we may also attribute the chemical change of the substrate to the partial liberation of surface energy which is brought by the combination of the carrier with the substrate.

We can now understand why that which above was termed "transmission effect" should not be represented as a kinetical problem only, for it is in the same time one in energetics. The quantity of the liberated energy depends both upon the nature of the combination which is effected between the carrier and the substrate and upon its intensity. It is easily comprehensible that a decisive rôle is played in this connection by the nature of the carrier which confronts a given substrate. Different carriers free different quantities of surface energy of zy. s. on combination with the same substrate. Not only relations which arise from chemical reactions between atoms come up for consideration in this connection, but mainly rather relations which are conditioned by the colloidal state of the zymoactive material, and arise from the space pattern and atomic constellation of the carriers and the substrate at their mutual association. Zymolabile carriers produce a considerable decrease in the surface energy of the zymoactive substance by this association, thereby calling forth the correspondingly great "transmission effect". Zymostable carriers, on the other hand, have but a small effect.

The protective action of the carriers upon the zymoactive substance is partially removed by the association of the carriers to the substrate. Consequently a corresponding dislocation which is conditioned by the intensity of the combination between the carrier and the substrate, and which liberates zy. s. occurs. The zy. s. thus liberated can fix itself upon the substrate and by this fixation some of the surface energy of the zy. s. is undoubtedly transformed into manifest chemical energy:

$$\begin{array}{l}\text{Transmission}\\ \text{process}\end{array}\left\{\left[\begin{array}{l}\text{Carrier} \longleftrightarrow \text{zy. s.}\\ \quad\vdots \\ \text{substrate} \longleftrightarrow\end{array}\right]\right\} \xrightarrow[\text{collision}]{\text{appropriate}} \left\{\begin{array}{l}\text{Carrier} \longleftrightarrow \\ \quad\updownarrow \\ \text{Substrate} \longleftrightarrow \text{zy. s.}\\ \qquad\qquad(\text{transmitted})\end{array}\right.$$

$(\longleftrightarrow = \text{loose combination})$

The transmission process can only take place of course, if the fixation of zy. s. by the carrier is sufficiently loose to allow the dislocation. If the zy. s. is closely fixed however, a zymophoric behaviour by the carrier is quite out of the question. Thus:

Carrier K $\longleftrightarrow$ zy. s (high derivatives) $\updownarrow$ easy linkage Dipeptids (low derivatives)	Easy dislocation of zy. s. and consequently an easy transmission.
Carrier X $\longleftrightarrow$ zy. s. (low derivatives) $\updownarrow$ difficult linkage Dipeptids (low derivatives)	Difficult dislocation and difficult transmission.
Carrier X $\longleftrightarrow$ zy. s (low derivatives) $\updownarrow$ easy linkage Higher polypeptids (peptones) (high derivatives)	Easy dislocation and easy transmission.

When high protein derivatives meet low derivatives, the dislocation and transmission are facilitated, since the association between carrier and substrate in this case is particularly easy.

On the basis of all that had been pointed out above. the answer to the question whether a given substance can act as a suitable carrier, is seen to depend upon the possibility of an association, in the sense already demonstrated in Part 1, between the carrier and the substrate in question, as well as upon the ability of the carrier to have entered into combination with the zymoactive substance without causing entire loss by this combination of the surface energy which the zymoactive substance possesses as a colloid and which it must liberate subsequently when the carrier and the substrate combine, if it is to effect chemical action such as hydrolysis or other cleavages.

The kinetic equation of an enzyme system must therefore take into account two factors: (1) the frequency of the "appropriate collisions" (see above) and (2) the quantity of surface energy ($\Delta\pi$), set free in a unit of zy. s. after the above mentioned collisions. With one and the same substrate both factors, the frequency as well as the $\Delta\pi$, vary according to the nature of the main and the subsidiary carriers.

Yet it may occur that a carrier T which is itself now zymophoric in respect of a given substrate is made zymophoric by the presence of a second, for its part zymophoric, carrier T_1 (Fodor and Frankenthal, 1930):

$$\mathrm{T} \longleftrightarrow \text{zy. s.} + \text{substrate} \longrightarrow \text{no transmission}$$

$$\mathrm{T} \longleftrightarrow \text{zy. s.} + \mathrm{T_1} \rightarrow \mathrm{T_1} \longleftrightarrow \text{zy. s.}$$

$$\mathrm{T_1} \longleftrightarrow \text{zy. s.} + \text{substrate} \longrightarrow \text{substrate} \longleftrightarrow \text{zy. s.}$$

The part played by T_1 is thus that of a mediator or even "activator".

The conception of the existence of mediators of this kind was advanced by the author (Fodor, Kuk and Frankenthal) as early as 1928. The fact of their existence has recently been confirmed by O. Warburg (1935), who ascribes a similar part to the "yellow flavin enzyme," as mediator of the hydrogen transmission in the alcoholic fermentation system of yeast.

The ideal form of the kinetic equation of, for instance, the hydrolysis of a dipeptid to amino acid molecules

$$\mathrm{NH_2\text{-}\overset{\displaystyle R}{\overset{|}{C}}H\text{-}CO\text{-}NH\text{-}\overset{\displaystyle R_1}{\overset{|}{C}}H\text{-}COOH} + \mathrm{H_2O}$$

$$= \mathrm{NH_2\text{-}\overset{\displaystyle R}{\overset{|}{C}}H\text{-}COOH} + \mathrm{NH_2\text{-}\overset{\displaystyle R_1}{\overset{|}{C}}H\text{-}COOH}$$

must be postulated under the following premises:

Let us conceive a single highly zymolabile carrier T. Let us further assume that none of the hydrolytic products act as carriers. Let the unit of zymoactive substance, whose quantity Z may be assumed to remain constant during the initial time interval t, call forth an energy change $\Delta\pi$ equivalent to the surface energy loss $\Delta\omega$.

Then the quantity of energy transmitted to the substrate will be $E = \Delta\pi . Z$ (= effect) and

$$\frac{dx}{dt} = E.k\,(a-x)^n = \Delta\pi.Z.k\,(a-x)^n.$$

In this equation a represents as usual the concentration of the substrate at the beginning of the action, $(a-x)$ its concentration

after a time t (x being the quantity transformed), k and n are constants of which the latter depends upon the frequency of the "appropriate collisions" and generally has a value of about $\frac{1}{2}$ but varies with the pH of the whole enzyme system. Under certain experimental conditions n may even be equal to 1. In this case E really being constant the equation would assume the external form of a reaction of the first order. We may easily see also from this equation how one and the same quantity Z can produce radically different degrees of zymotic activity (as measured by the quantity $\frac{dx}{dt}$) according to the quantity of the effect E, a quantity which is determined by the nature of the carrier.

To be sure, this kinetic equation is in practice rarely realised in its ideal form. Numerous disturbing factors intervene. Such for instance are the products of enzyme action which may either accelerate or slow the hydrolytic process, thus changing the value of both E and the constants.

From the point of view of kinetics, the enzyme action is thus seen to be a highly complex, and a but little elucidated process. It was only great optimism which moved former researchers to hope that they could make the kinetics of enzyme action conform with those of so simple a process as the cane sugar inversion found by Wilhelmy.

Natural phenomena are found to be more complex and intricate the deeper we penetrate into their profundities. To this fact the mechanism of enzyme action is an abundant testimony.

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A peculiar property of such an "Eloxal" (Electrolytically Oxidised Aluminium) is its porosity, the film being covered with a network of pores the diameters of which are of colloidal dimensions. It is this porosity of the Aluminium film in Eloxal that is responsible for its many valuable applications.

This porosity enables Eloxal to absorb liquids. The Eloxal plate can be charged with light-sensitive chemical either by tanking it in an aqueous solution of the reagent or (with water-insoluble chemicals as silver halides) by causing the reagent to be precipitated within the porous film. The Eloxal plate is now ready for the SEO photograph employing the usual photographic processes. Only, the pores in the oxide film have to be closed finally by rubbing the plate with either a suitable fat or wax. The cost of the Seo Eloxal photo is stated to be no higher than the ordinary photograph.

The Seo photo possesses many useful properties. It is not affected by temperature, by the common organic solvents, by sea-water, and by the ordinary corroding factors. The Seo photo can be heated up even to the m.p. of Aluminium (658°) when the photograph is still clearly distinguishable on the oxide film. These properties give the Seo photo a large field of utility. It is excellently adapted to the manufacture of Placards, Scales and other Measuring Instruments, Notice Boards, Passports and other Legal Documents, Maps and Plans, etc.

The porous Eloxal film allows the deposition of various colouring matters enabling the manufacture of "Coloured Aluminium". When Eloxal, deposited with colloidal gold, is heated to various temperatures, the surface of the material takes on various shades of rich brown-red tints. Beautiful imitations of the grain and colour of timber and marble can be imparted to Eloxal which can be used as fire-proof panelling in the interior decoration of ships, æroplanes, railway carriages, etc. It can also be used in the wide field of applied art and in the manufacture of fancy-goods.

The great variety and extent of use indicated above, to which Eloxal can be put, it is claimed, is of national importance to Germany which does not possess copper deposits and is endeavouring to minimise the use of the metal and its alloys. The development of Eloxal is, therefore, another step in the German effort towards national self-sufficiency.

Eloxal was invented and developed by Jenny and Budilhoff, two Engineers on the staff of Siemens & Halske, A. G., Berlin, who have protected the invention by a series of patents.

EMMENNAR.

Silica Fluff.

A NEW form of hydrated silica, having unusual properties, prepared by slow drying at low temperature of the transparent gel resulting from the action of silicon tetrafluoride on water has been described by Jacobson (*J. Phys. Chem.*, 1936, **40**, 413) and is called Silica Fluff on account of its fluffy nature. This extremely light, opaque, white powder has low specific gravity, contains inclusions of air bubbles (1 to 1·5 microns) which give colour phenomena with polarised light and which cannot be dislocated by a vacuum pump. Its percentage composition leads to the empirical formula $(SiO_2)_{12}3H_2O$ and the graphic formula has also been speculated.

K. S. RAO.

The Movement of Protoplasma in Plant Cells.

THE movement of protoplasma within the plant cell as a result of irritation is a well-known phenomenon, the wounding of Vallisneria and allied plants furnishing striking examples. Prof. Hans Fittig of the University of Bonn has investigated (*Forschungen und Fortschritte*, 1936, **12**, 160), whether in such cases, the cause of the movement is due to purely mechanical influences or whether it is traceable to any chemical stimulant formed as a result of the injury. Fittig, by careful experimentation, shows that the extract from crushed Vallisneria leaves contains a substance which is stable towards heat but susceptible to bacterial decomposition and which in dilutions as low as 1 in 2 millions causes the movement of protoplasma in plant cells. As a first step in the elucidation of the nature of this active principle, Fittig sought to find if any known substances are capable, in dilutions of a comparable order, of causing such protoplasma movement. He finds that Amino acids are capable of such irritation. α-Amino acids are the most active, the potency rapidly diminishing with the β, γ, etc., isomers. Further, the Amino acids in their naturally occurring

optical isomeric forms are very much more active than their artificially prepared optical antipodes.

The effects of different Amino acids on a given plant cell vary enormously. By far the most active are Histidine (effective in concentrations as low as 1 in 600 millions) and Methyl Histidine (1 in 3,000 millions). Fittig considers it probable that the Vallisneria extract used in his experiments contains either about 1% Histidine or about 0·2% Methyl Histidine. The extract did not respond to the diazo colour reaction with Diazobenzenesulphonic acid which is sensitive to Histidine in concentrations of about 1 in 100,000. Fittig does not, however, consider this as conclusive or even significant because the reaction is easily masked by the presence of Methyl Histidine and other foreign substances which presumably are present in the Vallisneria extract. Work is in progress to find other methods of detecting Histidine. The importance of Fittig's work lies in the fact that α-Amino acids which till now were considered to be physiologically indifferent in plant life are shown to be in reality very active substances comparable to the physiological potency in animals of Thyroxin, another (though highly complex and Iodine-containing) Amino acid.

EMMENNAR.

A New Mode of Fixation of Nitrogen in Soils.

DHAR AND CO-WORKERS, in their extensive investigations, have shown the importance of light in many oxidation processes taking place in soils. In a recent paper (*J. Indian Chem. Soc.*, 1936, **13**, 155–179) N. R. Dhar and S. K. Mukherji have pointed out a new possible way in which light is helpful in the fixation of nitrogen in soils. When some sterilised soil suspended in a medium containing dissolved carbohydrates (like glucose, cane sugar, molasses, etc.) is exposed to sunlight for a long time, it is found that there is an appreciable increase in the available and the total nitrogen contents of the soil. The energy set free during the photo-oxidation of the carbohydrates seems to fix the atmospheric nitrogen. The efficiency of nitrogen fixation obtained in the induced oxidation of sugars is of the same order as that with cultures of Azotobacter thriving in flasks containing solutions of energy-rich compounds. These observations have been correlated with the results obtained in some field experiments undertaken for studying the effect of molasses on soils.

K. S. G. D.

Thermal Decomposition of Talc.

EWELL, BUNTING AND GELLER (*J. Research National Bureau of Standards*, 1935, **15**, 551–556) describe the changes which accompany the careful heating of a specimen of nearly pure talc from Manchuria. The furnace employed for the purpose could be heated up to 1435° C., and the temperature rise adjusted to about 6° per minute.

Observations with a differential thermocouple revealed two endothermic effects (both irreversible) at about 530–572° and 860–953° respectively. Determinations were simultaneously made of the weight losses suffered by the sample at different temperatures ranging up to 1435°, the period of heating at each temperature being 2-22 hours.

X-Ray and microscopical examinations were made of the unheated material as well as of the material heated to different temperatures. The X-Ray camera was divided so that comparison patterns of the test and reference specimens could be obtained on the same film.

It was found that between 380–500° all the water present in excess of 1 molecule was driven off from talc but without any alteration in crystal structure. The molecule of combined water was removed at 800-840° and this was accompanied by breakdown of the talc into enstatite and amorphous silica and also by an increase in specific gravity. On further heating up to 1300°, the enstatite changed into clinœnstatite and amorphous silica into cristobalite. The final products of the thermal decomposition of talc were found to be clinœnstatite and cristobalite, and the specific gravity of the fully decomposed material was found to be 3·01 as compared with the value 2·83 for the unheated specimen.

K. R. K.

Histophysiological Study of Testis.

PROF. JACQUES BENOIT has a very interesting paper in the Actualités Scientifiques et Industrilles (*Exposés de Biologie*, 1935, **3**, 3–64) on "Le Testicule" as an organ elaborating the male sexual hormone. He has studied the testis from the morphological and histophysiological view-points. This

study has enabled the author to divide the testicular cells under three heads, *viz.*, the *lignée seminale* forming the reproductive cells, the cells of Leydig and the cells of Sertoli. The latter two sets of cells are probably derived from the same cellular layer in the Gallinacea and the same is also likely to be the case in mammals and the other groups of vertebrates. The transformation of the Sertoli cells into glandular interstitial cells is accompanied by the loss of Sertoli characters and the acquisition of a secretory activity. The cells of Sertoli play *vis-a-vis* to the seminal elements the rôle "d'un terrain somatique trophique". The interstitial cells secrete endocrines, which hormone is responsible in the development and functioning of the secondary sexual characters and the accomplishment of reproduction.

The Arteries of the Chimpanzee.

AS a result of the examination of ten specimens of the Chimpanzee (Pan spec ?), E. M. Glidden and C. F. De Garis (*Amer. Jour. Anat.*, March 1936, **58**, No. 2, 501) have distinguished five types of aortic arches. In one, which exemplifies the normal human sequence, three trunks, the *a. anonyma*, the *a. caroticus communis sinistra* and the *a. subclavia sinistra* arise from aortic arch. In the second type, *a. truncus communis* gives rise to *a. anonyma* and *a. carotis communis sinistra*. This condition is found in a single specimen out of the ten examined. The third pattern occuring in four specimens, simulates the first except that a small *a. thyroidea ima* arises directly from the arch between *a. anonyma* and *a. carotis communis*. The fourth type is characterised by the *a. thyroidea ima* arising from the *a. carotis communis* instead of directly from the arch. This occurs in two specimens. The last condition is characterised by the fusion of the bases of *a. carotis communis* and *a. subclavius sinistra* to form *a. anonyma sinistra*. The *a. thyroidea ima* always arises from this *anonyma sinistra*. This occurs in two specimens.

In the single specimen which the authors have dissected for the arteries of the descending aorta and of the pelvis and the extremities, it is seen that *a. subclavia* lacks the *a. thyroidea* inferior and the relation between the *a. axillaris* and *plexus brachialis* is seen to be different from that obtaining in man. The visceral branches of the descending aorta are in the main similar to the human pattern. In the pelvic region the obturatoria is rudimentary and the *circumflexa femoris medialis* arises from the external iliac.

The Idea of Contrasted Differentiation.

PETROLOGISTS are aware that during the last few years S. R. Nœkolds has been developing his hypothesis of contrasted differentiation to account for the variation in igneous rocks. His main contention is that in intercrustal magma reservoirs, differentiation yields two contrasted magma types—acid and basic, which manifest as intrusions, with the basic member invariably coming out first, and that most of the intermediate rock types are commonly the products of contamination. Recently Aurther Holmes (*Geological Magazine*, May 1936, No. 863) has shown that the idea of contrasted differentiation as advocated by S. R. Nœkolds is beset with many inconsistencies and objections so fundamental as to be in direct variance with the physico-chemical principles of crystallisation differentiation established by Bowen. In discussing Nœkolds's evidences in support of contrasted differentiation, Holmes observes that the occurrence of contrasted rock types in close proximity does not constitute any direct proof for contrasted differentiation especially in view of Fenner's observation where he has shown that the alternate outpourings of typical basalt and typical rhyolite with little or no lava of intermediate composition. Hence according to Holmes preference must be given to the hypothesis of progressive crystallisation differentiation for which there is at least a convincing experimental basis rather than contrasted differentiation for which there is no real evidence at present.

Recent Investigations into the Principles of Irrigation and Cultivation of Orchards.

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THAT irrigation is indispensable in many parts of India for the best production of horticultural crops is a fact widely recognised. In many of these areas, canal water is not available and recourse must be had to lifting or pumping from underground supplies. In the canal as well as in the pumping areas, water for irrigation is relatively limited. Economical and scientific use of the available supply is therefore of vital importance.

Because of wide variations in soils and of the extreme differences in topography, the cultural and irrigation methods must vary widely in different parts of India. During his recent visit to the United States of America the writer had an opportunity to discuss the various aspects of the problem connected with the cultivation and irrigation of orchards, a subject which has been receiving considerable attention at the hands of research workers in the University of California. These investigations have definitely modified certain old and widely current beliefs and have advanced new conceptions which afford a better understanding of the subject.

The practices of irrigation and cultivation are so interrelated that it is almost impossible to discuss the principles underlying each of these separately. It must be made clear at the outset that it is not the intention of the writer to discuss in this paper all the physical forces involved in the occurrence of moisture in the soil and its behaviour, but it is proposed only to speak of soil moisture from the view-point of its availability to plants.

The water which a soil absorbs and stores for use by plant roots is held in the form of moisture films which adhere to the soil particles. When water is applied to soils it distributes itself about the soil particles wetting each to its maximum film thickness as it passes downward under the influence of gravity. The amount of water held in the soil after the excess gravitational water has drained away and after the rate of downward movement of water has materially decreased, is termed "Field capacity" of the soil.

The downward movement of water in the soil is due almost entirely to gravity and not to capillary movement. Recent investigations show that capillarity cannot be depended upon to distribute moisture uniformly in the soil. The belief that "the moisture content of all of the soil occupied by the roots of the trees will be raised to a certain percentage by the applications of small amounts of water, because of the downward capillary movement of the water with a consequent equalisation of the moisture content of all of the soil" is incorrect.

When water is applied to a dry soil it is moistened to its field capacity to a definite depth. According to Veihmeyer[1] "All attempts to maintain a soil moisture percentage less than that which the soil would hold against the force of gravity, the maximum field or capillary capacity have met with failure." He further observes, however, "that the soil moisture supply could be kept above a certain minimum. The soil could be raised to a maximum content and this condition re-established when the plants had reduced the soil moisture supply to a certain minimum."

In view of the above investigations the amounts of water applied to a soil will affect only its moisture content to a certain depth and that much quantity of wetted soil will be raised to its maximum field capacity. Smaller amounts of water will wet a soil to its field capacity to a smaller depth while larger amounts will wet it to a larger depth. Hence, a light irrigation wets a shallower depth of soil to its field capacity than a heavy one does.

Soon after a soil has attained its "field capacity" the moisture content begins to decrease due to evaporation from the surface and extraction of water by roots of weeds or trees, that is, the moisture content fluctuates between "field capacity" and some percentage of moisture at which plants wilt and will not revive unless water is again applied. Soil physicists have named this stage of soil moisture as *permanent wilting percentage*, and the moisture in the soil above this condition is called the *readily available moisture.* Before we proceed to discuss as to how this readily available moisture is utilised by plants it is important to know how the water moves in the soil from one point to another. As already explained above, when water is applied, it penetrates the soil in a downward movement and laterally under the influence of gravity. Once the soil attains its "field capacity", the moisture, according to the recent investigations in the United States, remains almost stationary and is not able to move appreciably in an upward or lateral direction from the moist layers of the soil to the drier ones. In view of these investigations, therefore, the familiar conception that moisture is capable of moving in the soil in all directions through capillary forces needs modification.

Earlier investigators like King,[2] Hilgard,[3] and Longhridge and Widtsoe[4] have laid great stress upon the losses of moisture through evaporation from the soil surface by upward capillary movement. This theory of upward capillary movement in the soil apparently was advanced as a result of the study of the movement of moisture in soils contained in glass or metal cylinders where the lower ends remained in contact with free water. On the other hand, the study of the movement of moisture from a moist to a drier soil in the absence of water table within 6 to 10 feet depth received much less attention in early days.

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[1] Veihmeyer, F. J., "Some factors affecting the irrigation requirements of deciduous orchards", *Hilgardia*, 1927, **2**, No. 6.

[2] King, F. H., *Soil Management*, Orange Gudd Co., New York, 1–303.

[3] Hilgard, S. W., *Soil*, The Macmillan Co., New York, 1921.

[4] Widtsoe, J. A., *Principles of Irrigation Practice*, New Ed., The Macmillan Co., New York, 1914, 1–496.

However, as early as 1913 Rotmistrov[5] from Russia drew attention "that water percolating beyond a depth of 40 to 50 centimetres does not return to the surface except by way of roots." Harris and Turpin[6] and Alway and McDole[7] were some of the early investigators in the U.S.A. to study the movement of moisture from moist soils to soils containing lesser amounts of moisture. Their investigations indicated, though not very conclusively, that the movement of moisture, especially in an upward direction from moist soils to drier soils is not at all appreciable when the source of the moisture supply is not saturated soil in contact with a free water surface. The most outstanding of the present-day investigations in this respect are those of F. J. Veihmeyer[1] of the University of California. His extensive experiments in pots as well as in the field have demonstrated that the capillary movement of moisture from the moist to drier soil when the soil is not in contact with a free water surface is too limited in extent and rate to be effective for use by plants. After the water applied to the soil becomes uniformly distributed by gravity, or in other words when the soil attains "field capacity", the upward as well as lateral movement of moisture from the surface layers of soil is due to direct evaporation and the loss from the lower layers occurs chiefly by way of roots of trees or weeds growing on it. Mulching is useful in so far as it removes weeds, etc., which deprive the soil of its moisture. Commenting on the phenomenon of upward capillary movement of soil moisture Keen[8] observes, "Upward capillary movement of water is now known to be effective over short distances only. Hence, the conception of a mulch as breaking the capillary channels and thus preventing water from actually reaching the soil surface is invalid, unless a permanent or temporary water table exists within some 6 feet from the surface." It may be assumed, therefore, that in the presence of a permanent or temporary water table within 6 to 10 feet distance, the water in the soil moves by capillarity, the distance and rate being determined largely by the fineness of the soil particles.

Under these conditions capillary movement is most rapid in the coarser soils (sands), but only for a short distance. In the finer soils (clays) movement is slower but occurs to a greater distance. Such a capillary movement of moisture also occurs from the bottom of the irrigation furrows so long as water is running in them. It also takes place in shallow soils underlaid by hard pan after irrigation due to the hard pan serving as a temporary water table. However, in well-drained orchard soils of good depth and structure but with a low water table the capillary movement of water is of no practical consequence in irrigation practice.

If we were to find that the moisture in the soil after it has attained the stage of "field capacity", does not appreciably move in any direction in absence of a water table, as has been also the field observations of the writer in the Bombay Deccan soil, we should then unhesitatingly lay down the following principle for irrigation practices :—

> "That whatever the system of irrigation adopted, it must ensure that all of the soil in the root zone is wetted. If the irrigation water wets a part of the root zone, only the roots in the wetted area will have water and the roots in the non-wetted area will suffer from lack of it."

Having learnt how water occurs in the soil we now direct our attention to study under what conditions plants can make the best use of it. The important factors affecting the rate of use of water by plants are the extent and vigour of the transpiring leaf surface, atmospheric temperature, humidity of the air and air movement. The larger the leaf surface the greater will be the loss of water from leaves. The atmospheric combination under which the greatest use of water occurs is that of high temperature, low humidity and high wind velocity, conditions so very common in the arid zones of California and which are very similar to the severe weather conditions obtaining in most parts of Northern and Central India.

The consumption of a certain quantity of water by the plant is determined by its leaf surface and weather conditions irrespective of the kind of soil on which it grows, the soil merely serving as a reservoir from which water is extracted by the plant in accordance with its needs. Since light soil has a low water-holding capacity its supply is more quickly exhausted than a heavier soil with a higher water storage capacity. Consequently irrigations on light soils are lighter and more frequent. The amounts of water used by plants of similar leaf area and under the same climatic conditions are precisely the same whether growing on light or heavy soil.

The amount of water to be applied at each irrigation varies with the kind and depth of soil to be wetted and the moisture content at the time of irrigation. There is no advantage in applying water to soils already wet as it merely passes on downwards and is lost. The soil is said to be over-irrigated when enough water is applied to deep soils to cause percolation below the roots or waterlogging of shallow soils and when the applications are so frequent as to affect aeration of the soil.

The combination of fruit trees and cover crops needs more water during the growing season than trees alone ; therefore, in the rainless districts they should never be attempted unless there is an abundant water supply available from canals or rivers. The Philippine Department of Agriculture are conducting a series of experiments on the value of permanent cover crops in alternating rows with Citrus trees under very heavy rainfall conditions. The permanent thick bushes of *Crotolaria* sp. and such other legumes are expected in this scheme of cover cropping to

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[5] Rotmistrov, V. G., "The nature of drought according to the evidence of the Odessa Expt. Station, 1913, Russian ed.," 1911–1913, 1–66 (English translation), Sta. M. of L. and A., Dept. of Agri., Odessa.

[6] Harris, F. S., and Turpin, H. W., "Movement and Distribution of Moisture in Soil," *Jour. Agr. Res.*, 1917, **10**, 113-153.

[7] Alway, F. V., and McDole, G. R., "Relation of movement of water in a soil to its hygroscopicity and initial moistness," *Jour. Agr. Res.*, 1917, **10**, 391-428.

[8] Keen, B. A., "The Physical properties of the soil," *The Rothamsted Monographs on Agr. Science.*, Longmans, Green & Co., London, **1931**.

absorb the extra amount of water during periods of torrential rains and prevent erosion of the soil, as well to prevent leaching of manures.

As has already been stated, the loss of moisture stored in the soil is caused by extraction by the roots of the trees and other plants or weeds growing in the orchard and by evaporation directly from the surface of the soil. Viehmeyer's[1] experiments show that "The amount of water used in transpiration comprises a predominent part of the total losses from the soil under California conditions". While considering the problems of storage and loss of soil moisture we should not overlook the part the tillage plays in manipulating the soil for successful orcharding. According to Veihmeyer's[1] investigations cultivation alone does not help to conserve moisture in absence of a water table and if a water table does exist within 6 to 10 feet from ground level and water is lost by capillarity, there is a greater need for drainage in such soils rather than a mulch to conserve moisture. In the case of dry farming of grain crops, cultivation may help to some extent to prevent loss of moisture through soil cracks if they are of sufficiently large size; but the loss of water by evaporation from the small surface cracks under uniform soil conditions in an orchard takes place at such a low rate that probably nothing would be gained by covering them before the next irrigation is due.

The main purpose of cultivation in the light of recent investigations in California is to avoid weed competition or any other influence the weeds may have rather than the other effects such as soil aëration. Surface cultivation does not increase aeration in the soil depths occupied by the roots of the majority of our fruit trees and sufficient aeration ordinarily takes place in orchard soils regardless of whether or not the soil is stirred at the surface; and rapid nitrification may take place below the depths affected by tillage. On the other hand, unfavourable conditions for aeration may be produced if water is applied frequently enough to fill the pore space in the soil and maintain this saturated condition for long.

The usual practice of hand digging orchard soils at intervals after irrigation in the Bombay Deccan is certainly beneficial in a restricted sense in so far as it makes the soil more absorbent of irrigation water, but it should not be overdone with a view to aerating the roots or to conserving moisture.

In addition to the removal of weeds, cultivation is indispensable for planning irrigation methods, for preparing seed beds and incorporating cover crops and manures, for facilitating the control of certain pests and aiding in the absorption of water where it is a case of an impervious condition of the soil.

Deep tillage is often harmful in orchard soil inasmuch as it tears the roots of many shallow rooted trees. All tillage operations, therefore, in the orchard should be as shallow and only as few as necesary to accomplish the useful purpose given above.

The root activity of the tree is very much affected by soil temperature, soil oxygen supply and the presence of available nutrients in the soil. The wet soils are supposed to be cold. The soils naturally warm up as their moisture content decreases. Root growth and absorption are definitely retarded by keeping the soil too wet and are accelerated by permitting it to decrease in moisture content. A natural means by which soils are ventilated and aerated has to do with fluctuations in moisture content. Air is driven out when the soil is wetted and returns when it dries out. With the return of the air the soil warms up and the bacterial activity increases resulting in increased fertility available to plant roots. Different plants are said to have different ranges of soil temperatures at which their roots make active growth or remain dormant. The tropical and sub-tropical fruits are known to have relatively high temperature requirements for root growth.

According to Prof. Hodgson[9] of the University of California the Citrus tree shows no root activity below 55° F. and the roots grow most actively at approximately 80° F. Above 80° F. the rate of growth falls rapidly and at 90° F. it practically ceases. The root growth in relation to soil temperatures under tropical conditions may behave differently. It is imperative, therefore, that the study of soil temperatures in relation to root growth should occupy our immediate attention in orchard practices.

The problem of the setting of blooms in Citrus and other semi-tropical fruits in the Bombay Deccan is almost as much dependent on soil temperature as on a change of weather and the writer believes that the present exhaustive method of root exposure to force flowering of the above fruits could easily by replaced by a more rational system of judicious watering so as to allow moisture to fluctuate widely between the field capacity and the permanent wilting percentage. On the other hand, the problem of flower and fruit drop especially in arid regions and under hot severe weather conditions is often tied up with the lack of proper humidity in the orchard at the time of setting and the excessive transpiration taking place under these conditions. Much harm can be averted at this time by flooding the orchard at close intervals and maintaining a strong windbreak around the orchard. Again, the Dieback disease of Citrus trees in the Deccan in the retentive black soils with impervious sub-soils is as acute a problem as one connected very probably with the defective oxygen supply and the resulting low temperatures in the soil. The nitrifying bacteria also require a fairly high soil temperature (85° to 95° F.) and high oxygen requirements for their activity, conditions only possible if the soil moisture fluctuates far below the field capacity and above the permanent wilting percentage.

In view of the above remarks, it is necessary to allow soil moisture to fluctuate in wide limits in order to allow the soil to attain the required high temperatures.

Veihmeyer's experiments on deciduous fruits[1] (Prunes, Peaches and Apricots) and with various kinds of soils (clay, sands, loams) in North California show that plants are not at all adversely affected unless the soil is depleted of its moisture to the permanent wilting percentage. According to his investigations it makes no difference to the abovementioned trees so far as its normal growth and fruiting is concerned, however low the soil moisture may fluctuate between field capacity and the permanent wilting percentage. According

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[9] Hodgson, R. W., "Some fundamentals of irrigation," *Year Book of the Calif. Avo. Assoc.*, 1927.

to his findings there is no particular optimum water content for growth in the soil between field capacity and permanent wilting percentage at which plants grow best. This is a revelation to orcardists in India who are given to thinking that by keeping the soil moisture content at a high level by flooding the orchard, at close intervals during the maturing period, they are able to swell the fruits to larger size. Veihmeyer and Hendrickson[10] while experimenting in the North and Central California Fruit Valley found that the size of the peaches and grape berries did not seem to be affected by irrigation near the time of picking.

The principle of depleting soil of its moisture to a condition approaching the permanent wilting percentage is not only in common practice in the cultivation of deciduous fruits in North and Central California but it is now also engaging the attention of the growers of evergreen fruits like the Avocado and Citrus in Southern California. The writer believes, however, that with the scanty knowledge of the requirements of tropical fruit trees and of soil moisture conditions in India, it would be risky to allow the soil moisture to fluctuate very close to the permanent wilting percentage in the principal root zone of the trees, but it seems that some minimum safely above the danger point of wilting should be the limit.

Naturally the question arises as to how without the aid of scientific apparatus one should be able to judge whether the soil has enough readily available water or if it is very near the danger point of wilting. In fact the orchardist himself should be in a better position to judge when his trees need water than any one else because of his close associations with his trees as well as the soil. The best method by which the grower can decide when to apply water is by cautiously prolonging the irrigation intervals in a small portion of his orchard and watching the condition of his trees and feeling the moisture in the soil of the *principal* root zone by hand. After a few trials of this kind he will soon become familiar with the degree of soil moisture which would be safe for his trees and the condition of soil dryness which would cause wilting. Experienced practical irrigators usually foretell the approach of soil moisture to wilting percentage from a flabbiness and a slight change of colour in the leaves and stalk of the plants. The lack of readily available moisture is easy to detect in the case of succulent trees like the Papaya and the Banana but it is not always easy to detect this condition from many stiff leaved plants. In such cases Veihmeyer[1] suggests that some kind of broad-leaved weeds, if allowed to grow in the orchard, would serve as indicators of soil moisture. Generally these weeds in California are deep rooted enough to indicate by their drooping of leaves a depletion of the readily available moisture in the part of the soil occupied by roots of the trees. Where only small streams of water are available, as in most fruit areas in India, the anticipation of the time when the permanent wilting percentage will be reached is very important in order that irrigation may be started in good time to cover the whole orchard.

It is impossible to assign any specific water requirements for particular orchard trees. They vary with the age, vigour and size of the trees and in accordance to weather conditions, being lowest in the humid regions and highest in the drier regions. Irrigation practice must, therefore, be determined primarily on the basis of the water requirements of the trees, the water-holding capacity of the soil and the amount of moisture in the soil as determined by periodic examinations by means of a soil augur or some such instrument. In California it is a common sight to see Citrus growers testing soil moisture by means of big iron augurs.

The method of irrigation must be governed by the topography and supply and must be so arranged as to guarantee uniform distribution and penetration of water. Whatever may be the system of irrigation flood, basin, ring or furrow, water must penetrate to the lowermost root zone of the tree to obtain best results. The length of spacing of the furrows and duration of running water into the furrow will have to be adjusted according to the rate of downward and lateral percolation of water while irrigating that particular kind of soil. The soil between furrows drawn too far apart is likely to remain unwetted. Where irrigation furrows are drawn in the space between two tree rows and beyond the drip of the tree-crown as is the practice in Citrus orchards of Southern California, the roots underneath the crown of the tree will benefit from the irrigation water to the extent the irrigation water runs and percolates laterally in a definite length of time through the first furrow on the side of the tree row. In this method of soil management, manure and water having been applied from the time of planting mainly beyond the drip of the trees, the feeding zone of the roots is largely built up in the irrigated area near and beyond the drip quite unlike the feeding root zone of fruit trees very near the tree trunk in the Bombay Deccan and in many parts of India where the irrigation and manuring system consists in providing a round basin or a pit close to the trunk.

Systems of irrigation are a mere outcome of circumstances in different countries and different localities in the same country. The grape-vine orchards in Northern and Central California where water supply is plentiful are simply flooded in long strips of beds, the tree row being in the centre of the bed. In the new virgin soils of these vine-growing areas no necessity has yet been felt to manure or fertilise the orchards and there is no danger of leaching the fertilisers due to heavy overhead flooding in large basins. On the other hand, in more arid zones of South California leaching of nitrogenous fertilisers in Citrus orchards is a great problem to be guarded against. In the arid areas, the furrow method of irrigation is found to prevent leaching of fertilisers very efficiently. Flood irrigation is especially desirable in fine silty soils where there is any amount of objectionable salts or alkali present as in the soils of the lower Indus Valley, Rajputana and in many places in the U. P. and the Central Provinces.

In such alkali soils flooding in basins can be used to great advantage to leach down the harmful salts down below the root zone of the trees.

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[10] Hendrickson, A. H., and Veihmeyer, F. J., "Irrigation experiments with grapes," *Proc. Amer. Soc. Hort. Sci.*, 1931.

Orchards planted on more sandy soils should not be flood irrigated as these soils have a tendency to take too much water at the upper head. The irrigation furrows on sandy soils should be necessarily short as long furrows in porous soils waste much water by deep percolation (much far below the root zone of trees) in their upper lengths.

In the arid zones of southern California where irrigation water has to be brought from long distances, very elaborate and economical devices have been constructed to give a measured quantity of water just sufficient to wet the required depth in a definite period. In the Citrus orchards of California water is no longer conveyed in open dirt ditches but it is most economically carried through underground pipe lines. As the water reaches the orchard it is taken from the main pipe line and distributed by underground pipes to each tree row. Underground pipe lines are laid deep enough (3′—5′) to be out of the way of cultivation implements and are provided with concrete hydrants or stand pipes for each row of trees. These hydrants are usually fitted with valves for regulating the flow of water into them and have adjustable gates through which the water flows to the irrigation furrows. The flow of water is so regulated by the gates as to control its very gradual seepage into the sides and bottom of the furrows. The water reaches the end of the furrow in about one-fourth the time of the period of an irrigation. The practice in many groves is to run water to the end of the furrow quickly and then reduce the flow for the rest of the period of irrigation. Penetration at top and bottom run is thus about the same. A ditch is provided at the other end of the furrow to drain away the surface water running through the furrow during the period of irrigation. This drained water is re-used by pumping back for irrigating in the same orchard or for any other useful purpose. In California, application of water by this system, over a period of about 48 hours, is found sufficient for completley wetting the soil of the root zone of Citrus trees.

While discussing the adoption of different methods of irrigation as circumstances would demand, the unique practice of Island irrigation as followed in the flood swept area of South East China need a special mention. The type of Agriculture found in this country is exceedingly well adopted to the low lying, water-logged soils where rice is the chief staple crop cultivated and rotated with vegetables. The fruit and vegetable cultivation in this country comprises a very elaborate and intensive system of canals, dikes, raised beds and ditches.

The soils of these areas are of alluvial origin and their texture is very fine, being mostly clay, silt or fine loam. Most of these soils are very deep and of high organic content. The whole delta region is subject to heavy floods when the rivers are high in the summer monsoon and the ocean tide holds back their waters. The fields and houses of the area are protected by numerous mud dikes which are specially built round the land to keep back the floods. The inner protected delta land is used for the cultivation of rice, lotus and other water crops while the surrounding dikes are planted with fruits like Lychee, Lungan, Oranges, Peaches, and Papayas. Often the inner rice land is reclaimed for fruit and vegetable culture by dividing the low lying land into a system of raised beds and ditches. The raised beds, 15 to 20 feet wide, are planted out with fruits and the ditches $2\frac{1}{2}$ to 3 feet wide serve as irrigation channels as well as drains. Water is taken from the canal into the ditches at the time of high tide in the river and is driven out when it is low. To begin with, the ditches are very narrow and shallow and the beds are wide; but the beds gradually get narrower and higher by the gradual process of widening and deepening the trenches which get filled up by the deposited silt and have to be cleaned out each year and the mud smeared back over the beds as a fertiliser.

By the time the trees reach their most productive age, the constant deepening and widening of the trenches reduces the width of the bed to about 15 feet and depth of the trenches becomes 5 to 6 ft. Often the water table in such soils is fairly high and the water rises above to the tree roots on the raised beds by capillarity from the wide and sufficiently deep trenches which hold standing water for a considerably long time. The beds are kept scrupulously clean by weeding and other shallow cultural operations by hand. In a system of this kind of irrigation and cultivation, the soils however clayey and retentive, do not suffer from the packing action of overhead watering or hard pans brought about by tillage operations in irrigated lands in other parts of the world. Both sides of the raised bed having been provided with open drains there is absolutely no danger of oxygen deficiency in spite of the continuous capillary rise of water from the permanent water table of the beds close at hand or the flood waters standing in the ditches for a considerably long period. No effort is made to maintain any kind of mulch except that the muck from the trench smeared over the bed is allowed to crack. The constant supply of water in the trenches makes unnecessary any effort to prevent evaporation.

This system could doubtless be employed to advantage in some of the swampy areas in deltas of our big rivers which are low and subject to a flood or to submersion at high tide from the sea. In this regard we can draw much inspiration from the unique orcharding of the world's best pummelo gardens in Ban Mai in Siam situated in the delta of the Tachin River located about 50 kilometers southwest of Bangkok.

According to the investigations of Prof. Groff[11] of the Lingnan University, Canton, China, during the dry weather (between January and July) the tidal flow extends far inland and in the lower part of the river the water becomes extremely salty containing as much as 2% sodium chloride (very nearly approaching sea-water containing 2.7% sodium chloride). In this region the type of cultivation and irrigation is the same as the system of water farming of raised beds and ditches as followed in Southeast China. It is in these salty swamps that the world famous seedless pummelo called "The Kao Pan" attains excellence of quality unrivalled in any other part of the world.

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[11] Groff, G. W., and Reinking, O. A., "The Kao Pan Seedless Siamese Pummelo and its culture," *The Philippine Journal of Science*, October 1921, **19**, No. 4, Manila.

Sugar Industry of India (1934-35).*

UNLIKE in the previous year the world sugar consumption in 1934–35 exceeded the total sugar production by about 730,000 tons. This curtailment of sugar production is mainly attributed to the measures adopted by the U.S.A. Government in introducing the quota system of production. Java has again suffered heavily. Conditions in India during this year were however satisfactory and the industry kept up its progress. Unfavourable weather conditions and diseases affected the crop in the U.P. and the Punjab but for all-India there was an increase of about 40,000 acres in the land under cane cultivation and a 4 per cent. increase in the raw sugar output.

Of the total 142 sugar factories built for operation, 130 worked in 1934–35 while in the previous year only 112 factories operated. As a result of this there was an increase of 124,150 tons in the total sugar produced direct from cane. We, therefore, find an increase of 30 per cent. in the number of factories and a 16 per cent. increase in the sugar output over the previous year's figures.

The highest recovery for all-India during 1934-35 was 11.10 as against 10.98 in the previous year but there was a decline in the average recovery from 8.80 in 1933–34 to 8.66 in 1934–35.

Technical and agricultural work continued its progress in the experimental stations at Coimbatore and Pusa and also in the different provinces. This work was chiefly confined to cane breeding technique and varietal experiments. Experiments on the open pan system and trials of small plants were carried out in Bihar and Orissa and Bengal while in Bombay sugar was made by this process in eight places on the Deccan Canals. Cultural experiments on five varieties of beet in the N.W.F. Province showed German (22) to be the heaviest yielder.

The total value of sugar machinery imported into India during 1934–35 was about one crore of rupees while in the previous year it was 3.36 crores.

It should be noted that the total '*gur*' production in this year was 3,692,000 tons and was the highest figure for the last ten years.

In the year under review the total sugar produced from cane, from '*gur*' refining and by the indigenous processes amounted to 768,115 tons. The imports of sugar declined at the same time and were less by 38,000 tons than in the previous year. This decline in the imports from Java alone was 18,000 tons.

Java has suffered seriously by the loss of her Indian and Japanese markets and as a result had to effect drastic reductions in her sugar industry. The number of factories that operated, the acreage under cane cultivation and the quantity of cane harvested in the year 1934–35 were less than 50 per cent. of the previous year's figures.

Because of her preferred position in the American market Cuba did not suffer much. Cuban sugar industry was chiefly influenced by the reduction of tariffs and the introduction of quota system of production by the U.S.A. Government.

The future of Indian sugar industry continues to be bright. In the next year (1935–36) it is expected that the production will be 106,000 tons of sugar more than in 1934–35. There has not been any damage to the U.P. crop as in 1934–35. The time seems to be opportune to achieve a more settled market by finding out a uniform basis for grading sugars and adopting sale contracts more equitable between the manufacturer and the merchant.

G. GUNDU RAO.

* Review by R. C. Srivastava, Supplement to the *Indian Trade Journal*, May 21, 1936, published by the Manager of Publications, Delhi.

Lady Tata Memorial Trust.

THE Trustees of the Lady Tata Memorial Trust have announced the award of the following scholarships and grants for 1936—37. The international awards have been made mainly for the promotion of researches on the diseases of the blood with special reference to Lencæmias. Dr. Charles Oberling, Paris; Dr. Julius Engelbreth Holm, Copenhagen; Dr. Lucy Wills, London; Dr. Max Otto Kaalund-Jorgensen, Copenhagen; Prof. Eugene L. Opie of the Cornell University; Dr. Phil Karl Hinsberg, Berlin and Prof. J. McIntosh, London, are the recipients.

Indian Scholarships for the investigation of problems having a bearing on the alleviation of human suffering have been awarded to the following:—(1) Mr. M. C. Nath, M.Sc., to continue the chemical and biological analysis of proteins of Indian Foodstuffs, (2) Mr. R. Chakraborty, M.Sc., to continue the investigation of nutritional problems of Indian Foodstuffs with special reference to Vitamin C, (3) Mr. N. B. Das, B.Sc., to continue the work on the oxytoic harmone and on oxidation and reduction of systems in the body, (4) Mr. T. N. Ghosh, M.Sc., for research on the preparation of New Anti-malarials, (5) Dr. B. K. Nandi, M.Sc., Ph.D., A.I.C., for work on the synthesis of antimalarials of the plasmochin and atebrin types, and (6) Mr. H. S. Mahal, M.Sc., to investigate the rôle of "Choline Esterase" and to continue the work on anthelmintic drugs.

Science Notes.

Loss of Spirit Due to Evaporation under Indian Conditions.—Mr. K. R. Ganguly, Government Laboratory, Agra, writes.—Experiments, the results of which are given in Table I, were carried out to see how far spirits lose in strength under Indian conditions, when kept in bottles with faulty or loose stoppers. The nature of loss studied in this laboratory, situated at a place where almost throughout the year a very dry atmosphere prevails, may be taken as more or less the highest in India that may occur due to negligence such as keeping the bottle in an almost open condition due to faulty corks.

TABLE I.

a—Bottles kept tightly closed with corks.

b—Bottles kept open (plugged with loose cotton wool to prevent dust).

(Results expressed in % proof)

Days	I		II		III		IV		V		VI	
	a	b*	a	b*	a	b*	a	b*	a	b*	a	b*
Starting day ..	9·3	9·3	29·6	29·6	49·7	49·7	63·5	63·5	100·0	100·0	139·9	139·9
17th ..	9·3	8·9	29·6	28·8	49·7	48·5	63·5	61·9	100·0	98·9	139·9	139·2
32nd ..	9·5	8·8	29·6	28·2	49·6	47·5	63·5	60·9	100·0	98·0	139·9	138·7
51st ..	9·5	8·6	29·6	27·6	49·6	46·6	63·5	59·6	100·0	97·0	139·9	138·0
66th ..	9·4	8·3	29·6	26·9	49·6	45·4	63·5	58·3	100·0	95·7	139·9	137·3
81st ..	9·4	8·2	29·6	26·4	49·5	44·3	63·5	57·4	100·0	94·9	139·9	137·0
111th ..	9·4	7·7	29·5	25·3	49·5	42·5	63·5	55·3	100·0	92·9	139·9	136·1
148th ..	9·2	6·7	29·2	23·2	49·2	39·5	63·4	51·7	99·8	89·7	139·6	134·2
298th ..	9·1	5·4	29·2	19·8	49·2	34·6	63·2	44·2	99·8	81·9	139·6	130·6

*Mean of duplicates.

Plain country spirits of six different strengths, *i.e.*, 9.3, 29.6, 49.7, 63.5, 100.0 and 139.9 per cent. proof were kept in reputed quart bottles, which are stamped 'U. P. Excise' and are used in bottling country spirits in the United Provinces of Agra and Oudh. The dimensions of these bottles were: body, 8″; neck, 4″ and inner diameter of the mouth, 0.9″ to 1.0″.

The strengths under I and II were taken to study the condition of very dilute spirits such as obtaining in feints. The strengths under III and IV nearly correspond respectively to the minimum and the maximum issue strengths of the United Provinces. The strengths under Nos. V and VI correspond nearly to the strength of final products of distillation used for potable purposes by pot and patent stills respectively.

Rectified spirit of 60.0 O.P. strength was diluted with distilled water in order to obtain the different alcoholic strengths to start with. In the beginning each bottle was filled with 758 c.c. (1/6th of a gallon) of spirit; this liquid nearly filled up the bottles to the mouths.

The strengths were determined at the start and at different subsequent stages from specific gravities measured by a Pyknometer at 60° F.

The results of these experiments show that the percentage loss in *proof gallonage* is the highest in the case of the lowest strength and the lowest in the case of the highest strength spirit, but loss in *proof strength* is the highest near about the United Provinces' maximum issue strength. This is shown by the following figures deduced from those given in the Table I.

TABLE II.

	Maximum per cent. loss in *proof gallonage* due to deterioration of *proof strength* in about one year	Maximum loss in proof strength in about one year
No I	41·9	3·9
No. II	33·1	9·8
No. III	30·4	15·1
No. IV	30·4	19·3
No. V	18·1	18·1
No. VI	6·6	9·3

These results would be of interest in deciding questions of alleged evaporation, where wilful dilution is suspected.

Further experiments are being carried out to find out directly the vapour pressure of different strengths of alcohol-water solutions at ordinary temperatures.

* * *

A New Type of Vasculum for the Indian Climate.—Dr. F. R. Bharucha, writes from Bombay under letter, dated 29th April 1936:—Every field-botanist in India comes to realise very soon that the tin vasculum (black-japanned outside) ordinarily used in the West is almost completely useless for the Indian climate. It is my experience that many plants and particularly small flowers of the Papilionaceæ order gathered

during the day, dry up beyond recognition by the time they are taken to the laboratory.

Hence some experiments were undertaken to devise a vasculum most suited to Indian conditions. Tin was preferred to aluminium for making the vasculum as it lends itself to soldering and is not easily corroded by water and alkalies which are present in the soil attached to the roots of plants.

The vasculum was lined inside by a thin white asbestos sheet about 1/16in. thick. The lid of the vasculum which was made tight-fitting was also lined with the same material. To test its efficiency delicate flowers, like the garden Phlax and Canna, were placed inside the vasculum along with a thermometer. A control vasculum without any asbestos lining was set up. It was found that the flowers in the experimental vasculum remained fresh for a long time. By introducing a wet sponge in the asbestos-lined vessel it was found that the flowers remained fresh the whole day, even on days of intense heat.

In the course of these experiments it was noted that though the thermometer in the asbestos-lined vasculum recorded almost as high a temperature as in the control one, the flowers remained fresher in the former than in the latter. Two conclusions may be drawn: (1) that primarily a humid atmosphere is necessary for maintaining the freshness of the flowers, and (2) that a direct contact with the outside cover of the vasculum affects the flowers considerably; an intervening layer of a material of poor conductivity prevents flowers from wilting. A lighter vasculum can be made by lining it with limpet sheet instead of ordinary asbestos but this would cost double the price. To prevent tin from rusting the outside of the vasculum can be specially painted to an aluminium finish.

* * *

Archæological Discoveries in Kotah State.—In the course of a tour of archæological exploration organised under the auspices of the Kotah Government, Dr. A. S. Altekar, Manindrachandra Nandi Professor of Ancient Indian History and Culture in the Benares Hindu University, made several important discoveries. The most important among these is the discovery of three sacrificial pillars each bearing a record, dated in the year 295 of the Vikrama era, and announcing the performance of the *Tri-rātra* sacrifice by the sons of a Maukhari ruler. The earliest Vikrama era inscription, so far known, is dated in the year 282; so the new inscriptions are the second earliest records in the Vikrama era. So far the antiquity of the Maukharies could not be taken to a date earlier than the 5th century; the new records show that they were ruling as important chiefs a couple of centuries earlier and so far to the west as the Kotah State. These pillars were discovered in the village Badra.

Three Gupta period inscriptions were discovered, two at Charchoma and one at Mukundara. One of these contains an Ayurvedic prescription, the second records the foundation of a Śiva temple and the third mentions a chief who is known to have died while fighting with the Hunas.

In the Lakshmī-Nārāyana temple at Shergadh, two very interesting Paramāra records were discovered. These belong to the 11th century A.D. These records show that Lakshmī and Nārāyana are interlopers in their present abode which was originally built for Somanātha. When and why the latter gave place to the former, we do not know. The inscriptions describe a series of donations given to the Somanātha temple by the rulers and private individuals for different purposes connected with the temple worship.

Shergadh is now a deserted village, but during the period 800–1200 A.D., it was the headquarters of a flourishing district, as its old name *Koshavardhana*, "the increaser of royal revenue". shows. Several Jain temples and Buddhist monasteries existed there during this period and numerous records mentioning grants to these were discovered at the place. Another place, once flourishing but now deserted, was discovered on the tiger-haunted forests in the vicinity of the village Bilas. This forest is literally studded with old temples, sculptures and images. One of these was dedicated to twenty-four Jaina *Tirthankaras*, as the extant riches in the dilapidated temple show. Bhimagadh was another old flourishing fort, now altogether deserted. In two temples in the fort were discovered two inscriptions mentioning King Bhīma, who had founded the city and fort.

The discoveries made during the tour show that from about the beginning of the Christian era down to the advent of the Muslim power, the territories of the Kotah State were inhabited by cultured people, who lived harmoniously in spite of their following different religions and who had made a remarkable progress in sculpture, architecture and literature.

* * *

The Date of Bhārata Battle.—A paper of considerable interest on the date of the Bhārata Battle, was read by Dr. P. C. Sen Gupta, at the ordinary monthly meeting of the Asiatic Society of Bengal, held on Monday, 1st June. The date of the battle is of importance for fixing the chronology of the *Vedas*, *Brāhmaṇas* and the *Upaniṣads*. The previous researches on the subject have all led to inconclusive results. According to tradition, the date of the event has been severally given as 3102 B.C. (Āryabhata), 2449 B.C. (Vṛddha Garga) and 1421 B.C. (the astronomical writers of the *Purāṇas*). Dr. Sen Gupta, from a critical study of the astronomical references in the *Mahābhārata* itself, comes to the conclusion that the date of the battle is 2449 B.C.

In the paper, Dr. Sen Gupta cites a system of consistent astronomical references from the *Mahābhārata* from which he attempts an "approximate solution of the problem as one on conjunction of the moon with the sun and some fixed stars. He finds that the approximate position of the summer solstitial colure of the year of the Bhārata Battle passed through the star *Regulus*, whence the year comes out to be 2350 B.C.—a result which fairly agrees with the tradition ascribed to Vṛddha Garga that Yudhiṣṭhira became King in 2449 B.C. He then examines the year 2449 B.C. astronomically by a consideration of the mean motions of the sun and the moon and proves that the lunisolar phenomena of the *Mahābhārata* references did actually happen in 2449 B. C. He next calculates the apparent longitudes of the sun, the moon, and some stars

for some days of the year 2449 B.C. and shows conclusively that the fight began on the 14th October and lasted till the 31st of the same month and that Bhiṣma expired on the 20th December, one day after the sun had reached the winter solstice. So far as our knowledge goes these *Mahābhārata* references have not been used in any other previous researches. The author has supplemented his paper by citing some other *Mahābhārata* references showing that there was a time in the history of Hindu India, when the summer solstitial colure passed through the star *Regulus* and the vernal equinoctial year through the star group *Pleiades*, for which the mean date is 2350 B.C.

At the same meeting the following exhibits were shown and commented upon: (1) Chintaharan Chakravarti: *Newly Acquired Manuscripts on the Cult of Kubjikā*. (2) M. Hidayat Hosain: *A Persian Stencilled Wall-hanging Picture said to represent "Umar Khayyām"*. (3) Percy Brown: *A Metal Figurine of a Dancer.*

The following candidates were ballotted for as Ordinary Members.—Mr. Jitendra Mohan Sen, M.Ed., B.Sc., F.R.G.S., F.N.I. (2) Khan Bahadur Alfazuddin Ahmad, M.A.

* * *

Deutsche Akademie Scholarships.—The Indian Institute of the Deutsche Akademie has announced the award of seventeen new scholarships for the academic year 1936–37 to the following Indian graduate students who are to carry on higher studies in various German Universities:—*Medicine:* Miss Usha Haldar, M.B.B.S. (Delhi), and Mr. G. S. Guha, M.B. (Assam); *Mathematics:* Mr. Suprasanna Sengupta, M.Sc. (Rangoon); *Indology:* Mr. Aryendra Sharma, M.A. (Allahabad), and Mr. R. N. Dendekar, M.A. (Poona); *Chemistry:* Mr. N. K. Seshadri Iyengar, M.Sc. (Bangalore), Mr. Basudeb Banerjee, B.Sc. (Calcutta), Mr. N. K. Saha, M.Sc. (Allahabad), and Dr. A. K. Dutta, D.Sc. (Calcutta); *Engineering:* Mr. N. Anjaneyulu. B.Sc. (Benares), and Mr. Nand Lall Gulali, B.Sc. (Benares); *Archæology:* Mr. T. Balakrishnan Nayar, M.A. (Annamalainagar); *Veterinary Science:* Mr. P. C. Nag, G.B.V.C. (Sylhet); *Agriculture:* Mr. Panchanan Maheshwari, M.Sc., D.Sc. (Agra); *Mining:* Mr. B. S. Sanjeeva Reddi (Colarado, U. S. A.); *Fine Arts:* Miss Sheila Bannerjee (Calcutta); *Economics:* Mr. Bashesharnath Tandon, M.A. (Meerut).

* * *

Radio Research Board for India.—At the invitation of Prof. S. K. Mitra, a number of distinguished scientists, including representatives of radio research workers from Australia and Canada, met at London to consider the question of forming a Radio Research Board for India. Prof. S. K. Mitra, who was in England to acquaint himself with the latest developments in Radio Research, in the course of his speech, emphasised the need for a co-ordinate organisation with adequate funds at its disposal for conducting radio investigation in India. Prof. Mitra said "There are men available for such work in the Universities, men who by their training are particularly gifted for such type of work. But without the co-operation of Government Departments, like the Air-Ministry, the Meteorological and the Postal Departments, the Universities, where alone such work is now being carried on, cannot successfully conduct such investigations. The nature of the most helpful co-operation that is necessary is best exemplified by the *British Radio Research Board* which maintains a close touch between the various Government Departments and the Universities." Prof. E. V. Appleton, King's College, London, supported the need for a Board of the type envisaged by Prof. Mitra. Sir Frank E. Smith mentioned that various problems such as that associated with the field strength of received signals at different times of the day and at different seasons of the year with different wavelengths and with different transmitting aerials, are of a *local* nature, which can be solved by work in the country desiring the information. If the Research Board is founded in India, it will be of help, not only to India, but to the international Research work now being conducted in Great Britain and other countries. The British Radio Research Board will be glad to co-operate with any research organisation which might be established in India. Prof. A. S. Eve (Canada) and Prof. T. H. Laby (Australia) also emphasised the need for the formation of such a Board which will bring engineers and physicists together in solving both theoretical and practical problems.

* * *

The Indian Anthropological Institute.—In response to a general desire among the leading anthropologists of India, a Central Anthropological Association has been formed with its headquarters in Calcutta under the name of the Indian Anthropological Institute. Dr. J. H. Hutton, D.Sc., C.I.E., I.C.S., is the President, and Dewan Bahadur L. K. Ananthakrishna Aiyar and Rai Bahadur Sarat Chandra Roy are the Vice-Presidents of the Institute. Mr. K. P. Chattopadhya is the Treasurer and Dr. B. S. Guha and Dr. Panchanan Mitra are the Secretary and the Joint Secretary of the Institute, respectively. The Institute proposes to hold periodical meetings and promote anthropological research in India on scientific lines and publish a half-yearly journal.

* * *

The Central Jute Committee.—It has been decided to set up a Central Jute Committee under the Central Government of India. The function of the Committee will be to undertake agricultural, technological and economic research, the improvement of crop forecasting and statistics, the production, testing and distribution of improved seed, enquiries and recommendations relating to banking and transport facilities and transport routes and the improvement of marketing in the interests of the Jute Industry in India. The Committee will also be required to advise the Local Governments concerned on any points which may be referred to it, provided the subject-matter of the reference falls within the prescribed functions of the Committee.

The Secretary of the Committee will be appointed by the Governor-General in Council, and he will not be a member of the Committee. The Government of India have decided to finance the Committee for the time being by grants from the Central Revenues. The grants will not exceed

5 lakhs of rupees in a year and for the year 1936–37, a grant of Rs. $2\frac{1}{2}$ lakhs has been made.

The Headpuarters of the Committee will be Calcutta.

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Sir George Anderson has been permitted by the Government of India to relinquish his duties as Education Commissioner with the Government of India. Mr. Arthur Henderson McKenzie has been appointed to the post.

* * *

Deterioration of Structures in Sea-Water (Fifteenth Report).—His Majesty's Stationery Office. Price 12*s.* 6*d.* Post Free 13*s.* The problem of protecting structures against deterioration in sea-water has been exhaustively studied by a Committee of the Institution of Civil Engineers for over fifteen years. During that time, observations have been made in several parts of the world on the action which sea-water has exerted upon a wide variety of structural materials. The present volume constitutes an authoritative general survey of the problem as a whole and of the results achieved in the work already undertaken. The four main sections of the Report are:—Preservation of Timber; Corrosion of Steel and Iron; Protection of Steel and Iron by means of Paint and other Preservatives; and Deterioration of Reinforced Concrete. The Report is accompanied by a large number of tables and plates.

* * *

Yellow Fever.—The operation of direct air services from Central and East Africa to India has brought India within the reach of yellow fever. There has not been any case of yellow fever in India, but extreme precautions are essential particularly as the mosquito, *Stigomiya fasciata*, which is the transmitter of yellow fever virus, is common in most parts of India, particularly in the coastal tracts. The Government of India have taken up the matter for consideration and by a new Act, the air-port authorities at Karachi are empowered to take preventive measures similar to those which are taken by seaport authorities.

* * *

Oil and Soap Research.—Important decisions were reached at the meeting of the Oils and Soaps Committee of the Industrial Research Council, held during the first week of this month. According to an *Associated Press* report the Committee first surveyed the work done on Oils and Soaps and also the equipment and staff in different laboratories. Future research necessary was then considered and a programme was agreed to. The items decided were distributed amongst the different laboratories. They include work on fatty oils, including examination of the character of oils pressed from different races of linseed and examination of the best method of preparing paint oils, boiled linseed oil and stand oil and also the study of development of rancidity in oil.

Regarding soap, problems considered were the selection of soap stocks mixtures of fats used for soap-making, cause and cure of certain defects, *viz.*, rancidity and sweating and the study of soap detergency, *viz.*, cleansing power.

In the field of essential oils, it was thought that a selection be made from among the numerous essential oil plants known to grow in India. Some of the most important plants were selected for study, each to be examined in one or other of the laboratories represented.

One other important matter which the Committee decided was the utilisation of vegetable oils for lubricating purposes. Whether this would be practicable or not remains to be tested. Vegetable oil-producing industry in India is very large and besides extensive home consumption, India exported in 1934–35, Rs. 30 lakhs worth of vegetable non-essential oils.

* * *

The Effects of Storing Cotton Bales in the Open and Inside a Shed at Karachi.—In his investigation into "The effects of storing cotton bales in the open and inside a shed at Karachi", Dr. N. Ahmad, Director of Indian Central Cotton Committee's Technological Laboratory, Matunga, reveals some interesting facts and figures.

With the increase in the cotton export trade at Karachi, there has been a corresponding increase in the number of cotton bales stored prior to shipment, a small percentage of which could only then be accommodated owing to the paucity of sheds; the remainder were exposed to the action of salt, ozone in the sea, air, sunshine and rain. The author selected the three important trade varieties, namely, Punjab-American, Punjab-Desi and Sind-Desi for his invesitgation and analysed the effect of this exposure and the consequent deterioration caused by bacteria and fungi on the cotton fibre by applying the method of analysis of variance. He found that the average deterioration in spinning quality over a period of 18 months was 13.6% for Punjab-Desi, 15.6% for Sind-Desi and 5.2% for Punjab-American. The rate of deterioration was different for different cottons.

* * *

Quality of Sugar Manufacture in India.—A review of the quality of sugar manufactured by central sugar factories and refineries during the season 1935–36 has been published by Mr. R. C. Srivastava (*Indian Trade Journal*, Jan. 4, 1936, 1044). The quality is judged by two physical characteristics, colour and size of grain of sugar. About 25 per cent. of the factories in India produce one grade sugar only; but the most common practice is to produce two grades. The commonly manufactured qualities of crystal sugar in India at present are those having fine grain and medium or inferior colour. In the large grained sugars examined, the crystals were dull in appearance. As a rule the crystals showed mixed grain of varying sizes and irregular shapes; only a few samples showed well-defined edges. It may be remarked here that a feature of all samples of imported sugars was the uniformity in the size of grain combined with a good lustre.

* * *

Study of Malaria Problems.—The League of Nations Malaria Course was inaugurated on Monday, April 27, at the King Edward VII College of Medicine, Singapore (see *Curr. Sci.*, 1936, **4**, 542). The Hon'ble Mr. A. S. Small, Officer administering the Government, in welcoming the delegates said "In Singapore and Malaya, a great deal of work has been done in connection with malaria research and we in

Malaya are proud of the fact that, to a great extent, we have played a leading rôle in such of the work that has been done throughout the world. I understand that the problem of malaria control varies in different countries, but it seems to me that there must be certain guiding principles which are common to the problem in all the places and a course such as this where you are enabled to exchange your ideas, must tend, I think, to increase your experience and knowledge and help you to a favourable result in dealing with the problems that may face you in your country."

The programme of lectures include laboratory work at the College of Medicine with clinical examinations at the Government Hospitals supplemented by practical field demonstrations in and around Singapore Island. The candidates then proceed in groups either to the Federated Malay States or to Indo-China or to Netherlands Indies, for a three weeks' intensive study of the measures for the control of malaria and their different conditions.

* * *

The London School of Economics and Political Science.—A special course on Colonial Administration, which is designed for persons interested in the problems of Colonial Administration, including those actually in contact with such problems, whether as administrators, educationalists or missionaries, will be given at the London School of Economics and Political Science, University of London. It includes seminars for discussion in addition to formal lecture courses in anthropological, administrative, legal and economic aspects of colonial administration and includes comparative studies of the principal colonial systems. The session covers the Lent and Summer terms—11th January to 25th June 1937—and represents a full-time programme of study. Applications for admission should be made to the Secretary of the School, Houghton Street, Aldwych, London, W.C. 2.

* * *

Death occurred on 9th June of Dr. A. Moffat, former Professor of Physics, Madras Christian College. Dr. Moffat came to India in 1892 to join the staff of the College. He was a very popular professor and was a member of the Senate, Board of Studies and Syndicate of the Madras University. After retirement, he served the Union Christian College, Alwaye, in an honorary capacity. Until April last, Dr. and Mrs. Moffat were residing at Bangalore. Dr. Moffat went to England for medical treatment where he died.

* * *

Statistical Abstract for British India, 1923–24 *to* 1932–33.—We have recently received from the Manager of Publications, Delhi, the statistical abstract covering 951 pages (price Rs. 5–2–0). The publication also includes statistics relating to certain Indian States. The topics dealt with are divided into :—Area and Population ; Justice, Police and Prisons ; Registration ; Finance ; Coinage and Currency ; Banks ; Municipalities, District and Local Boards ; Education ; Press ; Co-operative Societies ; Agriculture and Land Revenue ; Forests ; Port Trusts ; Emigration ; Pilgrims ; Vital Statistics ; Medico-Legal investigations ; Mental Hospitals ; Railways ; Road Communications ; Foreign Trade ; Coasting Trade ; Ships Built and Registered ; Joint Stock Companies ; Life, Fire, Marine and Miscellaneous Insurance Companies ; Post Offices ; Telegraphs and Telephone ; Meteorology ; Irrigation Works ; Prices of Staple Commodities ; Industries ; Fabrics ; Trade Unions ; Patents and Designs and Mineral Production. The publication is well indexed.

* * *

ANNOUNCEMENT.

His Majesty, the King-Emperor, has been graciously pleased to grant permission to the Asiatic Society of Bengal to use the title "Royal" before its name.

The Society, therefore, will henceforth be known as the "*Royal Asiatic Society of Bengal*".

* * *

Seventh International Congress of Genetics.—In accordance with the resolution of the International Committee elected by the Sixth International Congress of Genetics and with the resolution of the Government of the USSR, the Seventh International Congress of Genetics will take place in the USSR. It is planned to hold the sessions in Moscow in the second half of August, 1937.

The Organisation Committee of the Congress is as follows :—

President.—A. I. Muralov (President of the Lenin Academy of Agricultural Sciences of the USSR) —Moscow.

Vice-Presidents.—N. I. Vavilov (Vice-President of the Lenin Academy of Agricultural Sciences of USSR)—Leningrad ; V. L. Komarov (Vice-President of the Academy of Sciences of the USSR)—Moscow.

General Secretary.—S. G. Levit—Moscow.

Titles and abstracts should be directed to the Organisation Committee and should be in their hands by February 15th, 1937.

The Organisation Committee will appreciate suggestions concerning the programme and other matters pertaining to the Congress.

For all questions in connection with the Congress write to :

ORGANISATION COMMITTEE of the Seventh International Congress of Genetics, Institute of Genetics, Academy of Sciences, Bolshaya Kaluzhskaya 75, Moscow, USSR.

Telegrams : MOSCOW GENETICA.

* * *

It is announced that the Fifth Conference of the All-India Ophthalmological Society will be held in Lahore from the 20th to 22nd December, 1936, under the presidency of Lt.-Col. E. O'G. Kirwan, I.M.S. One Session of the Conference will be devoted to a discussion on the ocular disorders in diabetes.

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We acknowledge with thanks the receipt of the following :—

"Actualités Scientifiques et Industrielles," Nos. 134, 135, 137, 142, 150, 155, 158, 177, 222, 224, 234, 236, 249, 250, 253, 256–259, 261–263,

265–266, 270, 273–274; 278–280; 282–286; 288–294, 297–298, 302, 304–35, 307, 314, 318–319, 323.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Pt. 5, May 1936.

"Journal of Agricultural Research," Vol. 52, Nos. 3 and 4.

"The Allahabad Farmer," Vol. X, No. 3, May 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4353–4356.

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"Indian Trade Journal," Vol. CXXI, Nos. 1560–62.

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"The Calcutta Medical Journal," Vol. 30, No. 11, May 1936.

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International Institute of Agriculture." Rome —"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 4, April 1936.

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"Proceedings of the National Academy of Sciences, India," Vol. VI, Pt. II, May 1936.

"Review of Applied Mycology," Vol. 15, No. 4, April 1936.

"Journal of the American Museum of Natural History," Vol. 37, No. 5, May 1936.

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"Journal of Research, National Bureau of Standards," Vol. 16, No. 1, Jan 1936.

"Ceylon Journal of Science," Section D, Vol. IV, No. 1.

"Science and Culture," Vol. I, No. 13, June 1936.

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CATALOGUES.

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Everest Expedition.

MOUNT Everest, the world's highest peak, has once more defied man's attempt to climb its summit. The early advent of the monsoon and the heavy fall of snow rendered all heroic efforts unsuccessful and a retreat of the adventurous expedition has been officially announced, but this unsuccessful attempt has yielded much valuable information. The party under the leadership of Mr. Ruttledge have discovered a new point of attack which would be of great value on a future occasion.

Academies and Societies.

Indian Academy of Sciences:

May 1936. SECTION A.—SH. NAWAZISH ALI AND R. SAMUEL: *Absorption Spectra of Tetra-Alkyl Ammonium Salts. Contributions to the Theory of Co-ordinate Linkage IX.* Some molecules of tetra-alkyl ammonium iodide possessing a true covalent N-I bond exist in equilibrium with the dissociated molecules of the salt. This indicates that nitrogen under favourable conditions can be penta-covalent in agreement with a pair-bond theory of valency. K. C. SUBRAMANIAM: *Magnetic Susceptibilities of Some Organic Compounds in Different Physical States.*—The changes in magnetic anisotropy on melting and solution can be attributed to the break-up of polymers present in the solid state. P. S. VARADACHARI AND K. C. SUBRAMANIAM: *Magnetic Studies of Sulphur and Some Sulphur Compounds.*—Solutions of sulphur in carbon disulphide and sulphur monochloride have been studied by the Curie method. There is no evidence to indicate the presence of S_2 in sulphur monochloride solutions. B. R. SETH: *Vortex Motion in Rectangular Cylinders.* S. PARTHASARATHY: *Diffraction of Light by Ultrasonic Waves.*—A detailed relation between the angle of inclination of the oscillating quartz, and the diffraction spectra produced by it *at these angles, is given.* N. S. NAGENDRA NATH: *Neutrinos and Light Quanta.*—It is found necessary to introduce the spin of the neutrino in the neutrino theory of light in order to obtain two photon operators for each energy state of photons and derive the Planck formula. C. V. RAMAN AND N. S. NAGENDRA NATH: *The Diffraction of Light by High Frequency Sound Waves: Part V. General Considerations—Oblique Incidence and Amplitude Changes.*—The intensity distribution will not be symmetrical in general. R. K. ASUNDI AND R. SAMUEL: *Electronic Configuration and Bond Energy.*—The method of molecular orbitals can be satisfactorily interpreted as an electron pair-bond theory of valency. S. PARTHASARATHY: *Ultrasonic Velocities in Organic Liquids. Part III.—Esters and Ethers.* MOHD. ISRARUL HAQ AND R. SAMUEL: *On the Absorption Spectra and Linkage of Inorganic Nitrates and Sulphates in the Vapour State.*—The bond between the metal and the oxygen atom in the nitrates and sulphates for the vapour state is of the covalent type.

May 1936. SECTION B.—A. C. JOSHI AND J. VENKATESWARLU: *Embryological Studies in the Lythraceæ III.*—A study of the structure and development of the ovule and the embryo-sac in *Ammania*, *Nesæa* and *Woodfordia* and the development of pollen, male gametophyte, endosperm, embryo and seed in the family. M. S. RANDHAWA: *Marked Periodicity in Reproduction of the Panjab Freshwater Algæ.*—Observations extending over two years have shown that in hot summer months, when nearly all ponds and tanks dry up, the *Oedogonium* is found in perennial streams only. In the rainy season very few algæ with thick-walled oospores are seen. In the autumn the *Spirogyra* become fertile. The *Rhodophyceæ* show a luxuriant growth in cold freshwater stream during winter. In the months of spring—March, April and May—nearly all algæ with thick-walled oospores and zygospores are in a ripe condition. M. S. RANDHAWA: *Genus* 'Anabænothrix' *and Parallelism in Evolution in Freshwater Algæ.*—A detailed description of three species of *Anabæna*-like blue-green algæ is given. M. A. H. QADRI: *Studies on the Mouth-Parts of Mallophaga Infesting North-Indian Birds.*—A comparative study of a large number of forms from simpler to specialised ones.

National Academy of Sciences, India:

May 1936.—D. N. MOGHE AND R. V. SASTRY: *The Field of a Non-Static Spherical Condensation.*—A generalisation of Schwarzschild's internal solution for an incompressible fluid sphere is given. V. V. NARLIKAR AND D. N. MOGHE: *A Note on a General Line-Element.* N. R. DHAR AND E. V. SESHACHARYULU: *Nitrogen Fixation and Azotobacter Count on the Application of Molasses and Sugars to the Soil in Fields—Part I.* N. K. SAHA: *On the Reconstruction of the Mass-Defect Curve and the Stability of Beryllium Isotope* Be^8_4.—The mass-defect curve for the nuclei He^4, Be^8, C^{12} Si^{23} forming the series X^{1n}_{2n} is constructed on the new "mass-scale" with the help of transmutation data and the few new mass-data of Bethe. M. N. SAHA AND L. S. MATHUR: *A Critical Review of the Present Theories of the Active Modification of Nitrogen.*—All the existing theories regarding the phenomenon of active nitrogen have been criticised. It is concluded that atomic nitrogen has nothing to do with the active modification and the experiments which establish its presence are not correctly interpreted. It is shown that the long life of the afterglow which is about 5½ hours according to the recent experiments of Lord Rayleigh throws a new complexion on the phenomenon. It is thought that in active nitrogen the molecule is raised to some state composed of two ^2D atoms and probably located at 9.77 volts. JAGRAJ BEHARI LAL: *A Note on the Colouring Matter of the Flowers of* Lantana camera *Linn.*—The anthocyanin colouring matter has been isolated. N. L. PAL: *Hydrogen Ion Concentration and Titratable Acidity at Different Stages of Fruit Ripening.*—There is no direct relationship between the pH and titratable acidity. N. R. DHAR AND S. K. MUKERJI: *Alkali Soils and Their Reclamation—Part I.* N. K. CHATTERJI: *Studies in the Respiration of Mango Leaves* (Mangifera Indica).—The Ontogenic drift of *Mangifera* leaves in relation to CO_2/O_2 activity has been traced out. G. R. TOSHNIWAL, B. D. PANT, R. R. BAJPAI AND B. K. VERMA: *Study of Ionosphere at Allahabad.*—Observations for November and December, 1935, show that 75 meter waves are usually reflected from the F-region. Sporadic E reflections, however, have been observed on several nights. HAR DAYAL SRIVASTAVA: *New Hemiurids (Trematoda) from Indian Marine Fishes.—Part I.—A New Parasite of the sub-family* Prosorchinæ *Yamaguti*, 1934.—A new species of the genus from the intestine of the fish *Seriolicthys bipinnulatus* from Puri, Bay of Bengal, is described. HAR DAYAL SRIVASTAVA: *New Allocreadids (Trematoda) from Indian Marine Fishes.—Part I.—New Parasites of the Genus* Helicometrina *Linton*, 1910.—Two new species of the genus *Helicometrina* Linton obtained from marine fishes at Puri, Bay of Bengal, are described.

Indian Chemical Society:

March 1936.—S. K. SHARMA: *Application of the Thiocyanogen Value in the Quantitative Determination of Oleic and Linolic Acids in Natural Oils, which are Free from Linolenic Acid, according to Kaufmann.* N. R. DHAR AND S. K. MUKERJI: *New Aspects of Nitrogen Fixation and Conservation in Soil. Part I.* N. R. DHAR AND S. P. TANDON: *Oxidation of Nitrites to Nitrates in Sunlight.* (LATE) ANDREW NORMAN MELDRUM AND MORESHWAR GOVIND BHOJRAJ: *Condensation of Chloral with Acid Amides. Properties of—CH(OH).CCl$_3$ Group.* PHULDEO SAHAY VARMA AND C. SREENIVASMURTHYACHAR: *Halogenation. Part XIV.—Iodination of Aromatic Hydrocarbons and Bromotoluenes.* PHULDEO SAHAY VARMA AND M. K. SRINIVASAN: *Halogenation. Part XV.—Chlorination and Bromination of Cumene and* p-*Cymene.* PHULDEO SAHAY VARMA AND T. S. SUBRAHMANIAN: *Halogenation. Part XVI.—Bromination and Iodination of Mesitylene.* SUSIL KUMAR RAY: *Parachor and Chemical Constitution. Part V.—The Structure of "Liquid Crystals".* ASHUTOSH DAS AND RAJENDERLAL DE: *Negative Ferric Hydroxide Sol.—A Modified Method of Its Preparation.* PROMODE BEHARI BHATTACHARYYA AND KALIPADA GANGULI: *On the Physico-Chemical Properties of Electrodialysed Gels of Silica, Alumina, Ferric Hydroxide and Their Mixture. Part I.—Ion Exchange.* (LATE) A. N. MELDRUM AND R. D. KOTWAL: *A Note on the Constitution of the Reduction Product of Trichloromethylparaconic Acid.*

The Indian Botanical Society:

June 1936.—P. C. MALLICK: *A Device for maintaining Constant Temperature and Humidity in a Glass Chamber.* C. V. KRISHNA IYENGAR: *A New Type of Electric Recorder for Plant Autographs.* D. P. MULLAN: *On the Mucilage-Glands and Absorbing Hairs of* Pedalium murex *Linn.* J. H. MITTER: *Some Recent Contributions to Our Knowledge of Heterothallism in Fungi* (*Presidential Address, Indian Botanical Society,* 1936). E. W. ERLANSON: *Plant Colonisation on Two New Tropical Islands.*

Meteorological Office Colloquium, Poona:

May 12, 1936.—Dr. K. R. Ramanathan.—"Stüve and Mügge's paper on 'Energetics of weather'."
May 19, 1936.—Mr. S. Basu.—"Emmon's paper on 'Atmospheric structure over the southern U.S.A. Dec. 30–31, 1927, determined with the aid of sounding balloon observations'."
May 26, 1936.—Dr. S. K. Banerji.—"Application of Kinematical laws of an Isobaric Field deduced by Dr. Pettersen."

University and Educational Intelligence.

University of Bombay:

The Syndicate have decided that the Professorship of the Department of Chemical Technology be renamed the *Ranchhoddas T. Mody* Professorship of Chemical Technology from the 5th June 1936 in accordance with the direction of the Court. As, however, it is not possible to pay the entire salary of the Professor out of the income from the Endowment, the Senate will have to make an annual grant to meet the expenditure.

It is proposed to increase the number of Scholarships in the Chemical Technology section to 6—two for the first year and four for the second—each scholarship to be of the value of Rs. 50 per month. It is also proposed to increase the Fellowships to 4, each being of Rs. 75 per month. The Fellowships will be filled up only as the research scheme progresses and after a report has been received on the work done by the present Research Fellows.

University of Calcutta:

Grants.—The Senate at their meeting held on 23rd May, sanctioned a grant of Rs. 3,000 to the *Narasiksha Samiti,* Calcutta, out of the Rai Viharilal Mitra Fund for the furtherance of their schemes for the training of teachers.

Change in Regulation.—Aeronautics has been introduced as an alternative subject in the course of studies for the B.E. degree examination in Civil and Mechanical Engineering.

Lady Hassan Suhrawardy Medal.—Sir Hassan Suhrawardy has offered 10 shares of the Reserve Bank, of the face value of Rs. 1,000 for creating an endowment in the name of his wife, the late Lady Shahar Banu Begum Suhrawardy. Out of the interest of the amount, a medal will be awarded annually to a lady graduate of the Faculties of the University for the best essay on Health Education.

Ghosh Professor of Applied Chemistry.—The Senate, at the meeting held on 23rd May, appointed Dr. Bireschandra Guha, D.SC. (Lond.), to act as Ghosh Professor of Applied Chemistry with effect from 1st June 1936 to 30th April 1937.

Ghosh Travelling Fellows for 1936–37.—Subodhchandra Ray, Esq., M.A. (Subject: 'Education of the Blind'); Dhirendranath Banerjee (Subject: Cholera Kidney and Cholera Toxin).

Award of Research Degrees.—Mr. P. C. Mahanti, M.SC., has been admitted to the degree of Doctor of Science for his thesis entitled "Investigations on the Band-Spectra of Diatomic Molecules" and "Studies of Electric Movements".

Research Scholarship for Mining and Metallurgy. It is understood that the Consul-General for America has informed the Calcutta University that a scholarship for the academic year of 1936–37 is available for Indian students at the Montana School of Mines. The School is located in one of the principal mining and metallurgical centres of the world and offers a 4-year course leading to a Bachelor of Science degree in the fields of mining, engineering and metallurgy including ceramics. One scholarship is offered for each consular district. In the case of Calcutta consular district, this would signify Bengal, Assam, Bihar, Orissa, the United Provinces, the municipal districts of Delhi and Simla, the Indian States within this area, Sikkim, Bhutan and Nepal. If, however, two or perhaps more students should be interested, they may make applications in the usual way direct to Dr. Francis A. Thomson, President, Montana School of Mines, Buttee, Montana, not later than August 1936.

University of Madras:

I. M. R. Ry. Rao Bahadur A. Lakshmanaswami Mudaliar, Avl., B.A., M.D., F.C.O.G., has been appointed full-time Vice-Chancellor during the period of leave of the permanent Vice-Chancellor, Mr. R. Littlehailes, C.I.E., M.A., from the 5th June to the 28th August 1936.

II. Dr. M. Damodaran, M.A., D.SC., F.I.C., Director, University Biochemical Laboratory, has been promoted from the grade of Reader to that of Professor in the scale of Rs. 750–50–1,000.

III. Messrs. S. Vaiyapuri Pillai, B.A., B.L., and R. P. Sethu Pillai, B.A., B.L., have been appointed Reader and Senior Lecturer in Tamil in the Oriental Reserach Institute.

IV. The following persons have been declared qualified to receive the Degrees noted below :—

Doctor of Philosophy.—

1. Miss C. Minakshi, M.A., for her thesis "Administration and Social Life under the Pallavas, The Kailasanatha Temple, etc.".
2. Miss Eliza V. Paranjoti, M.A., L.T., for her thesis "Saiva Siddhanta".

Doctor of Science.—

S. Gopalakrishnamurti, M.A., for his thesis "Atomic Energy, States of Tellurium, Iodine and other Related Elements".

Master of Science.—

1. N. Kesava Panikkar, B.A. (Hons.), for his thesis "Studies on South Indian Brackish Water Actiniaria".
2. P. K. Sesha Ayyar, B.SC., for his thesis "Absorption and Fluorescence Spectra of Organic Compounds".
3. T. K. Srinivasan, B.SC., for his thesis "Action of Sulphuric Acid on Cotarnine, Action of Bromine on Narcotine, etc."
4. T. Varahulu, B.A., for his thesis "Physical and Chemical Studies on Sugarcane-Jaggery".

V. The Sir J. C. Bose Prize of the value of s. 350 has been awarded to Mr. Kaviraj Dhirendranath Ray, M.SC., Calcuttla, for his thesis on "A Critical Study of Hindu Medicine".

University of Mysore:

Examinations :

The results of the examinations held in March 1936 were announced. They were as follows :—

Sl. No.	Name of Examination	Examined	Passed
1	Intermediate	1,151	418
2	B.A. (New)	126	65
3	B.A. (Old)	37	9
4	B.Sc. (New)	150	69
5	B.Sc. (Old)	1	..
6	B.A. (Hons.) Preliminary ..	37	26
7	B.Sc. (Hons.) Preliminary ..	58	48
8	B.A. (Hons.) Final ..	32	29
9	B.Sc. (Hons.) Final ..	37	29
10	M.A. Qualifying Test ..	2	2
11	M.Sc. Qualifying Test ..	2	2
12	B.T.	66	43
13	F.E.	74	48
14	S.E.	77	50
15	B.E.	38	30
16	Second M.B.B.S. .	31	14
17	Final M.B.B.S.	35	11

Recognition of Medical Degrees by the British Medical Council.

The Executive Committee of the British General Medical Council has resolved that the degree of M.B., B.S., granted by the Universities of Bombay, Lucknow and Madras together with other qualifications granted by the Universities of Bombay and Madras, which were presumably registerable, should again be recognised for registration if granted on or after February 25, 1930, and that the degree of M.B., B.S., granted by the University of Patna should be recognised for registration if granted on or after May 11, 1935, the date on which the University was included in the first schedule to the Indian Medical Council.

Reviews.

Introduction to Quantum Mechanics. By L. Pauling and E. B. Wilson, Jr. (McGraw-Hill Publishing Co., Ltd., London, 1935.) Pp. xiv + 468. Price 30*s*. net.

In the course of the ten years since its inception the subject of Quantum Mechanics has grown with extreme rapidity and has now reached a stage when the foremost scientists are acutely conscious of the necessity for new fundamental extensions. No student of Physics or Chemistry can now afford to be ignorant of the methods and important results of this young branch of knowledge. There is no dearth of books on the subject : in fact most of the advanced general text-books contain chapters dealing with the fundamentals. Still the new book by Pauling and Wilson fulfils a definite want, *viz.*, that of the student with limited mathematical equipment who is desirous of acquiring a good working knowledge of the subject. The classical books in this field have set out with the intention either of providing an authoritative compendium for specialists or exhibiting new ways of presentation. The book under consideration has, on the other hand, the student and the non-physicist constantly in mind and the treatment is suited to self-study. It is very encouraging to the student to be told that "an extensive previous knowledge of partial differential equations and their applications in

mathematical physics is not a necessary pre-requisite for the study of Wave Mechanics and indeed the study of Wave Mechanics may provide a satisfactory introduction to the subject for the more physically minded or chemically minded student". The spirit displayed in this quotation runs through the entire book. In keeping with this point of view matrix mechanics and Dirac's theory receive only a very brief introductory treatment at the end of the book. Wave Mechanics is, on the other hand, treated in detail and its several methods are lucidly explained with applications to definite problems. The two introductory chapters give the student an excellent orientation towards the problems of the old quantum theory, which first found a solution in Quantum Mechanics. The Schrodinger equation is introduced on its own merits as being a description of Nature worthy of confidence just like the second Law of Thermodynamics. The necessity for the existence of eigen-values of the parameters occurring in a differential equation is finely illustrated by a geometric consideration. The subsequent chapters deal with the solutions of the Schrodinger Equation in the various well-known cases of the oscillator, the rotator, the Hydrogen atom, etc., the mathematical steps being fully explained and the properties of the new functions encountered being derived as occasion demands. The Schrodinger Perturbation theory is fully explained with illustrative examples while the other methods of approximately solving the wave equation such as the variation method, the Wentzel-Brillouin-Kramers technique, Slater's method for many electron systems, and Hartree's method of the self-consistent field are explained without going into details in the case of the more difficult of these methods. The student is now and again assisted by timely repetition of definitions. The Helium atom, the Hydrogen molecule-ion and the Hydrogen molecule are discussed in detail as providing typical examples of the methods previously explained. The rotation and vibration of diatomic and polyatomic molecules are briefly considered and Quantum statistics, and the Uncertainty Principle are also touched upon. There are a number of appendices, most of them giving mathematical details kept out of the body of the book. Some problems to be worked by the student are appended to the various sections. Their value will be enhanced if some hints for their solution and the results are briefly given, say at the end. As is usual with American publications the book is finely got up, and somewhat highly priced. We have noticed a few harmless misprints, *e.g.*, on pages 264, 282, etc. Every advanced student of Physcis and Chemistry may heartily be recommended to make a close study of the book. We are convinced that the perusal of more advanced treatises and the original papers will then occasion no difficulty.

Mathematics of Modern Engineering. Vol I. By R. E. Doherty and E. G. Keller. (John Wiley & Sons, New York; and Chapman & Hall, Ltd., London, 1936.) Pp. 1–314 (i–xxi). Price 17*s.* 6*d.* net.

This joint work of "an engineer who has worked with mathematics and of a mathematician who has worked in engineering tempered by the atmosphere of the engineering office and the class-room" is designed as a course of study for undergraduates who aspire to work later in the higher levels of engineering service. Not the least interesting part of the work is the foreword to instructors wherein is explained the method of approach of the authors towards mathematical teaching in engineering institutions. This foreword of nine pages ought to be printed as a separate brochure and free copies of the same supplied to those who are responsible for the direction of engineering studies in this country as this would go a long way in bringing about the right attitude of engineers towards mathematics in place of the prevailing misconception that relegates it to the position of the Cindrella of the engineering curriculum. One very frequently hears the cry that mathematics taught at college is absolutely useless to the engineer in "after life". To people of this frame of mind the reviewer would strongly recommend a careful reading of pages xii–xiii of this foreword. It comes as a surprise that in the General Electric Organisation fifteen years ago practically all the engineering problems requiring real scientific analysis were referred to a very few individuals most of whom had received their college training abroad and that a remodelling of the courses of study with a definite orientation towards mathematical and theoretical work has gone a long way towards setting this right. According to the authors "the thing that seems to count professionally is the cultivated intellect" and there is no better way of securing this than by a rigorous discipline in mathematical

analysis. While it is true that the majority of engineering graduates of the average calibre have no opportunities for original work, it is a suicidal policy to frame the curricula of engineering studies with only such types in view. What is wanted is a course that is suited to produce engineering graduates who are capable of exercising leadership not only in the highly technical sides of engineering but also in commercial engineering and in executive capacity. This book is designed as a course for undergraduates who aspire to such leadership.

The difficulties of writing a text-book to suit these needs is however very great. The recent advances in engineering have utilised the services of so many branches of higher mathematics that it would be impracticable to incorporate accounts of all these in a book designed primarily for engineers. There is perhaps no branch of engineering so elusive or undefined as "Engineering Mathematics" and certainly none more often sinned against. We have scores of text-books on this topic which are either a heterogeneous collection of problems from different branches of engineering collected to illustrate special mathematical methods or a sort of collection of mathematical formulæ, at best a *mathematiker Hilfsmittel* for engineers. The list of the branches of mathematics used to-day in engineering which the authors have prepared makes imposing reading and serves to bring home this difficulty vividly. Theories of periodic orbits, the special three body problem, the damped pendulum, quasi-differential and integral equations, partial differential equations of the eighth order, dyadics and tensors, calculus of variations, vector analysis, Heaviside operational calculus, dimensional analysis, topology, analytic theory of differential equations and theory of functions of a complex variable constitute a formidable list indeed. Add to these, the theory of matrices and Riemannian and non-Riemannian geometry and one has a clear idea of the impossibility of writing a book giving accounts of all these topics.

One could, nevertheless, adopt the compromise of preparing a suitable mathematical environment for the proper appreciation of these topics and this appears to be the method chosen by the authors. With only the first volume before us it is difficult to judge correctly how far the authors have been successful in this attempt. This volume consists of four chapters. The first giving a general introduction to the mathematical formulation of engineering problems is admirably done. The second chapter, headed "Basic Engineering Mathematics," treats ordinary differential equations, determinants, Fourier series, solution of algebraic and transcendental equations, dimensional analysis and graphical and numerical methods. This chapter contains, therefore, most of the mathematical methods in every-day use in engineering and the authors are to be congratulated on their treatment of solutions of equations and dimensional analysis. This book shows better than any other the great power of the method of dimensions. Particular mention may be made of the exhaustive discussion of Græffe's general theory and the π theorem of dimensional analysis. The inclusion of the principle of similitude is a welcome and novel feature. The third chapter on vector analysis, although it covers only about fifty pages is just as good as, if not better than, most elementary texts on the subject like those of Gans or Runge or Coffin. It also contains a short but excellent introduction to dyadics. The fourth chapter on Heaviside's operational calculus, gives the latest developments in this branch and incorporates the unusual but extremely welcome practice of adding a good introduction to the theory of functions of a complex variable. This was the right place where the authors might have introduced an account of integral equations but perhaps this is reserved for the second volume.

If the contents of Vol. I are any indication of what the second volume is going to be, we can safely say that this series will easily constitute one of the best works on Engineering Mathematics so far published. If an Honour's Course in Engineering is ever established in our Universities this book might be unhesitatingly described as an ideal text-book. Even otherwise some of the methods and topics dealt with in the book would be very usefully taught in the ordinary courses.

Prominence may be given to the authors' coining of the phrase "*Engineering functions*" for the "well-behaved" functions $y = f(t)$ which are such that in $t_1 < t < t_2$,

(i) y is not infinite,
(ii) there is exactly one value of y for every value of t,
(iii) y has only a finite number of maxima or minima, and
(iv) y has not more than a finite number of finite discontinuities.

B. S. M.

Graphical Solutions. By C. O. Mackey, Cornell University. (John Wiley & Sons., New York; Chapman & Hall, Ltd., London, 1936.) Pp. 1–130. Price 12*sh.* 6*d.*

The title of this work indicates that it treats of the solutions of different engineering problems by graphical methods. The scope of the book is, however, not so exhaustive. Problems of graphic statics, graphical solutions of algebraic, transcendental and differential equations and the graphical methods of Fourier analysis do not find any place in the book. In the author's own words, he has "not attempted to read and abstract everything that has been written on the subject" of graphical solutions. The book is the outcome of a course of lectures offered by the author himself and confines itself to solution of equations and derivation of functional relationships by the methods of scales and charts and the problem of curve fitting. The treatment is elementary without sacrificing elegance or clarity. It is eminently practical and is illustrated by a wealth of examples, mostly from problems of mechanicsl engineering.

The chapters on intersection charts and alignment charts go much farther than most books on the subject. The author goes up to the limit of the construction of net work charts to solve equations in five variables. The use of determinants in constructing alignment charts with three scales is a novel feature of the work.

The best part of the book is the last chapter wherein is given an excellent account of the constantly recurring problem of finding an empirical equation to fit observed experimental data. A detailed treatment is given of the determination of constants when the assumed equations are known by applying the methods of selected points, residual summation and least squares. The treatment of three-constant empirical equations is also exhaustive and one would have liked to have the hyperbolic functions introduced here. While the methods for determination of constants is fully explained, nowhere does one find methods for guidance in the choice of the number of constants in the empirical equation tried for a particular set of data.

This book will certainly be of great use to students of mechanical engineering, especially in the study of heat engines. The last chapter on curve fitting deserves to be very widely known to all practising engineers. The printing and get-up are excellent and the price too appears reasonable.

B. S. M.

Commercial Fertilisers, Their Sources and Use. By Gilbert H. Collings, Associate Professor of Agronomy, Clemson Agricultural College. (P. Blackiston's Son & Co., Philadelphia, 1936.) Pp. xiv + 356. Price \$3·25.

A compendious text-book suitable for use in Colleges of Agriculture and comprising practically the author's class-room lectures in the subject, this handy volume will be found to meet the needs of a much wider circle of agriculturists than the College students for whom it is primarily intended. The author takes full note of the great development in fertiliser research in recent years and of the many important changes in the concepts on plant nutrition and has made a special point of giving actual research findings gathered comprehensively from most important research centres. American experience naturally predominates but on fundamental questions all available sources are laid under contribution. Descriptions are given of the sources, the methods of manufacture and trade relating to all the different commercial fertilisers at present on the market including the new products like Ammophos, Leunophos, Nitrophoska, Nitropotasse, Nitrochal and so on, while among organic manures the preparation and value of synthetic or artificial cattle manure is also described. The description of the methods of fixation of atmospheric nitrogen cover all known methods though one wishes they were fuller. So likewise are the methods of manufacturing superphosphates and the several concentrated and reinforced forms of this important fertiliser. The chapter on the borderland problems like the fertiliser value of elements other than nitrogen, phosphorus, and potassium forms interesting reading and fairly summarises present-day ideas as far as they can be on such a fast moving new branch of research. Sulphur, magnesium, iron, manganese, sodium, boron, chlorine, copper and even radium are touched upon under this head and their rôle as far as is known is indicated. "What fertilisers shall I use for my soil and how much?" is certainly the question for which the interested reader would like to obtain a helpful answer in a book of this kind; we are still far away from being able to give a precise answer to this practical question of every-day importance

without running the risk of dogmatism or half knowledge. The doses recommended vary within very wide limits and afford at best only reasonable guidance. Nevertheless research is continuously in progress to devise methods of determining the manurial needs of soils quickly enough for practical purposes and the name of Wagner, Kellner, Ville, Neubauer and Schneider will readily be remembered in this important branch of research. The book gives a full and interesting account of the various laboratory tests, the Neubauer, Hoffer, Thornton, and the Troug methods—all of which are used with varying degrees of usefulness for this purpose. We should have preferred greater emphasis being placed on the importance of field experiments in this connection and an account given of some of the excellent methods coming into vogue nowadays which are designed to reduce errors in field trials to a minimum and to afford quick and fairly reliable answers. This we believe is somewhat of a serious omission in an otherwise comprehensive text-book.

A useful feature of the book is the section on the calculation of quantities of manures required to make up mixtures from various formulas and for judging comparative valuations of the different fertilisers on the market from "Unit" values. Several examples are worked out, which will be found very helpful. The statistics of the world's resources, production, and trade of the different fertilisers should interest the lay reader and are quite impressive. Germany, for instance, leads in the use of fertilisers with a total annual consumption of about 1,800,000 tons, with the U.S.A., France, Japan, Italy, the Netherlands and Great Britain coming next in the order mentioned; the U.S.A. leads in the use of phosphatic fertilisers, while Germany leads in the use of nitrogenous and potash fertilisers. The per acre consumption of fertilisers for the cultivated area is put down at 105 lbs. for Holland, 70 lbs. for Germany, 33 lbs. for France, and Great Britain, and only 10 lbs. for the U.S.A. The world's reserves of fertiliser minerals are also estimated and it is computed that even at the present rate of consumption they cannot last for more than a thousand years. What will happen if India and China should begin to use artificial ferilisers as largely as Europe and America or if the latter should use them at the rate at which a country like Holland is using is rather a frightening prospect for mankind on this globe. The book is both interesting and up-to-date and should form a welcome additon to the number of text-books on the subject at present in use.

A. K. Y.

Introduction to Human Parasitology. By Asa C. Chandler (Chapman & Hall, London, Fifth Edition, 1936.) Pp. xvi+661. Price 25*sh*.

Since the publication of the fourth edition of this work in 1930 the science of Human Parasitology has undergone much change and numerous new problems have arisen while many of the old ones have become clarified. It seems to be the sad fate of humanity to fall a constant prey to one disease or another and probably the discovery of new maladies or fresh strains of old ones will continue as long as discerning man lasts. The discovery of a disease brings in its wake numerous problems of importance; the discovery of the parasitic organism, the study of its life-history, the methods of prevention and cure of the disease, etc., and indeed no problem of human welfare has received so much attention as human parasitology.

The author of the book under review, who is a parasitologist of great repute and long experience, has brought out a volume which has all the merits of a scientific treatise without the disadvantages of its narrow outlook. The story of the ills to which the flesh of man is prone, is a fascinating story though sordid in its details, and the usefulness of a work of this sort can only be judged by the extent to which the moral of the story is brought home to the readers. The long chapter on the part Bacteria play in undermining the health and happiness of the human race does not form part of the book and the author begins his account with the Spirochætes, though it must be admitted that the Spirochætes resemble Bacteria more than they do the Protozoa but "until the bacteriologists are prepared to assume full responsibility for them, the protozoologists will have to care for this orphan which Schaudinn left on their doorstep". But like all orphans, the Spirochæte is a most active, adaptable and vivacious organism and not a little misery and unhappiness are to be laid at its door. Relapsing fever and Syphilis would conjure enough pictures to treat them with scientific severity rather than with careless contempt.

It appals one to think that animals so low in creation as the Protozoa could wield so much power over human life. Nevertheless

it is true that this group of tiny animals is responsible for the death, annually, of an incredible number of humans. Malaria alone takes a toll that defies imagination, and that, even though practically everything is known about it. To this may be added the more important of the others,—Amœbæ, Trypanosomes and Leishmanias—a pretty kettle to stew man in. Then there are the worms, some of which like Schistosoma Trichinella, Ancylostoma and Filaria add not inconsiderably to the woes of man. The importance of Arthropods in this scheme of things is two-fold; a few are themselves parasites of no mean calibre but their real interest lies in the fact that they act as transmitters and intermediate hosts of myriads of smaller parasites conveying them from man to man and themselves none the worse for it. Ticks and mites, bed bugs and lice, flies and mosquitoes, fleas and gnats form a most imposing array of organisms which have all conspired to make man the unhappy animal that he is. Indeed, one would be tempted to single out any one of these and ask like the poet, "Did He who made the lamb make thee."

Such is the material which the author has endeavoured to present, not only to the layman but to the specialist as well, in the six hundred and odd pages of packed information. The parasites and their life-histories, the characters, the treatment and methods of prevention of the diseases caused by them are all dealt with in great detail. Useful and practical hints are offered for the alleviation of human suffering caused by the parasites, and throughout the book, there is a piquancy of style so essential in dealing with a problem of this sort. A fascinating story fascinatingly told.

B. R. S.

The Indian Zoological Memoirs. I.–Pheretima. By Karm Narayan Bahl. (Lucknow Publishing House, Lucknow; Second Edition, 1936.) Pp. x+85. Price Rs. 1-8.

The revised and enlarged second edition of this book has just been published. It will be remembered that in 1926, Dr. K. N. Bahl who is the editor of the *Indian Zoological Memoirs*, himself brought out the first of the series on the Indian Earthworm, Pheretima. A number of useful additions have been made in this edition as compared with the first one published ten years ago. In the introduction has been incorporated a classification of the Chætopoda and a list of Indian Oligochæta and more especially, the species of Pheretima, has been compiled, which will doubtless prove useful to all students of Indian earthworms. The chapter on Receptor organs is an addition while that on the habits and distribution has been amplified. The chapter on Development, has been expunged from the second edition, for reasons which the reviewer cannot quite follow. The *Memoir* does not restrict itself to the anatomy only and the information contained in the chapter on Development would not have been out of place. Many of the other chapters have been rewritten and all the latest literature on the subject has been incorporated. The paper used in the second edition is better and the types are clearer. It must be admitted, however, that the binding is very flimsy and the copy in the hands of the reviewer is already threatening to disintegrate. The book is in keeping with the latest of the series of the *Memoirs* more recently issued and it will prove useful in all colleges and schools where the Indian Earthworm is studied.

B. R. S.

Electrical Engineering in Radiology. By L. G. H. Sarsfield, M.Sc., M.I.E.E., A.Inst.P. (Chapman & Hall, Ltd., London, 1936.) Pp. 284. Price £1 5s.

Mr. Sarsfield has supplied a long-felt want in his admirable treatise on "Electrical Engineering in Radiology".

The Radiological Research Department at Woolwich has done splendid work for many years and Mr. Sarsfield has had ample opportunities of studying at close quarters all the problems he deals with in his book which has a large number of illustrations and many plates. There is a very good section on the lay-out, fittings and electrical dangers of Radiological Departments and the book is the most comprehensive work on the subject yet published. No X-Ray Department of any standing should be without a copy.

T. W. BARNARD.

La Diffraction des Electrons dans ses Applications. By Jean J. Trillat. [Actualités Scientifiques et Industrielles.] (Hermann et Cie, Paris, 1935.) Pp. 59. Price 18 *Francs*.

The publication of this excellent monograph on the diffraction electrons and its application by Professor Trillat is very opportune. Much work has been done in this branch of physics during recent years

and the need of a suitable book on the subject is often felt. This need is now met by the above monograph by Professor Trillat who is himself a pioneer in this field of research.

The monograph is divided into five chapters, the first of which deals briefly with the apparatus and experimental methods. In the second chapter is set forth all the recent work on the application of electron diffraction to the elucidation of the surface structure of metals, structure and orientation of crystals in metallic deposits, the nature of polish and other allied subjects. All the recent work on these lines by various workers in the field like G. P. Thomson, Finch, Kirchner, Trillat and others find a place in this chapter. Professor Trillat's work on the structure of thin films of long chain organic compounds like fatty acids, cellulose and rubber is also discussed in detail. The last two chapters are devoted respectively to the diffraction of electrons by gases and vapours, and to the diffraction of slow electrons. The monograph is well written in easy French and contains a comprehensive Bibliography on the subject which adds very much to its value. Perhaps the monograph would have been even more useful and valuable if the use of electron diffraction (in gases and vapours) for the study of molecular structure had been discussed a little more in detail. It can be recommended to all students of physics who wish to make a preliminary study of the subject before studying original papers. The monograph is sure to be welcomed by all workers in this field.

S. R. S.

La determination du sexe et heredite. By par Emile Guyénot. [Actualités Scientifiques et Industrielles.] (Hermann et Cie, Paris, 1935). Pp. 77. Price 20 *francs*.

A review of our present knowledge of the factors which control the appearance of sexuality in the lower animals, is written for general students and non-specialists. Known instances of sex-inversion in fish, amphibians and birds are described together with the results obtained when males were crossed with males, and females with females. Different types of sex-heterochromosome combinations are illustrated, as well as their behaviour during maturation. Sex-linked inheritance is explained by diagrams.

In connection with intersexes the author calls attention to the essentially unstable nature of the physical manifestation of sex (phenotype), which is dependent upon the attainment of an equipoise between two antagonistic sets of physiological factors. Both sexes are bipotential. There is no definite demarcation between maleness and femaleness and the relative position at which a state of balance is attained in each individual is determined by both genetic and environmental influences.

It is regrettable that the author decided to omit all bibliographical references merely because his work was of a limited scope. For this very reason the need for a list of sources is felt. Sex in humans is not dealt with and plants are barely touched upon. The reader of this useful review will want to learn more about the subject. Sex concerns everyone, and some knowledge of chromosome, and of which parent determines the sex of the offspring would destroy many superstitions even among the educated.

A Glossary of Technical Terms for Use in Indian Forestry. Indian Forest Records, New Series, Vol. II, No. 1. (Manager of Publications, Delhi. 1936.) Pp. 45. Price As. 5 or 6*d*.

In any technical vocabulary, words often have or acquire meanings which bear no relation to their original significance in common parlance. In Forestry, there is a further complication inasmuch as some of the terms used are defined by State Legislation, so that the same word used professionally connote different things in different countries. Just to cite an example, the term "Cattle," under the Indian Forest Act includes elephants, camels, buffaloes, etc. The appearance of *A Glossary of Technical Terms for Use in Indian Forestry*, therefore, fills a very real want in the profession. It is authoritative, being adopted for official use by the Silvicultural Conference, Dehra Dun, 1929, and revised in 1935.

By minimising cross references, the bulk of the book has been, with advantage, considerably reduced. The type and get-up of the Glossary make for easy reference work.

There are three Appendices. In the first is a list of the Silvicultural Systems compiled from Prof. Troup's work on the subject, with their French and German equivalents. It is noteworthy that under Shelterwood Systems, the expression "Blendersaumschlag" is given without an English

equivalent but with a short explanatory note, which gives a rough idea of the system more readily than any literal and pedantic translation. Appendix II details "Three Classification into Crown Classes" and the "Classification of Thinnings," while the last Appendix gives a list of "Forestry Terms used in the U. S. A. and their English Equivalents". One cannot help feeling that the usefulness of this Appendix would have been even more, if the German and French equivalents of the terms had also been given.

This book should find a place in the Library of everyone interested in Indian Forestry.

EMMENNAR.

India in 1933-34. (Manager of Publications, Delhi, 1935.) Price Rs. 1—10—0.

India in 1933–34 is the latest report prepared by the Bureau of Public Information for presentation to Parliament in accordance with the requirements of the 26th Section of the Government of India Act. This survey, which is issued under the authority and with the general approval of the Secretary of State for India, must not be taken to mean that the approval of either the Secretary of State or of the Government of India is implicit in every individual "expression of opinion". The report attempts to present in an abridged manner the general trend of events both in the Political and Administrative Spheres during the calendar year 1934 and outlines the developments in other departments in the financial year 1933–34. Those passages of an explanatory or descriptive character in respect of the subject-matter in former reports, have either been totally omitted or greatly reduced in length to keep down the size of the volume. The section on Provincial Administration, etc., has been left out but a separate chapter on the Bihar Earthquake forms a special feature of this volume.

The year 1934 will be handed down to posterity as one of the most memorable, if for no other reason than for the terrible seismic catastrophe which almost coincided with the beginning of the year. In respect of the area and of the extent of damage both to property and human lives, this seismic disturbance has very few rivals. The effect of the Earthquake was felt over an area of nearly two million square miles in India and Tibet alone, and was recorded by most of the seismological stations in the world. The devastations in certain areas in Northern Bihar were at once complete and widespread. The loss of human lives has been estimated to be 7,253 and this must be considered as remarkable in view of the fact, that in an area of 6,000 square miles, no masonry structure was left undamaged and that twelve towns with populations ranging from 10,000 to 60,000 were wiped out.

Apart from this visitation of natural fury, the crowded period of 1934 is not without interest or material. Political interest, in the main, is centred in the activities of the National Congress. The suspension of civil disobedience, which had borne no practical fruit, was as much an indication of the policy of Government as the realisation of the futility of resistance to constituted authority on the part of individuals comprising the Congress Executive. By the conclusion of the period under review, the Joint Parliamentary Committee Report was published, which may be considered as the culmination of a definite stage in the unremitting efforts to bring about constitutional reform for India. A noticeable improvement in the relations between the Government and the Congress was observable throughout this period, and Government, relieved of a pre-occupation with the task of maintaining public peace which was being threatened by the civil disobedience movement, were free to attend to administrative activities, such as the scheme for the amelioration of the economic problems of the country. Among the notable enactments of economic legislation may be mentioned the Bills for the constitution of a Reserve Bank and the amendment of the Tariff Act. Another important measure, which was passed during the Winter Session of the Assembly, was the Indian States Protection Bill which seeks to protect the administration of Indian States from the unreasonable attacks in the British Indian Press. The defence policy of Government was not without discussion, and the motion that the recommendations of the Indian Capitation Tribunal's Report was unduly favourable to India was talked out. The financial position of the country is ably surveyed and the exposition of the budgetary position of India is admirably revealed in the epitome of the speeches of the Finance and

the Railway Members introducing their respective budgets.

The communal situation was far from satisfactory and tension was increasing in acuteness. Riots which partook of a communal colour occurred at various places in connection with important festivals of both Hindus and Moslems. The communal disputes in British India had their repercussions in similar incidents in Indian States also. The terrorist movement in Bengal, which had been dormant for sometime, suddenly shot into activity in the form of a dastardly attempt on the life of the Governor of Bengal. This outrage served to awaken public opinion in Bengal to this terrible menace and the press was loud in denouncing the terrorist cult.

The other important developments dealt with in this report are those relating to Agriculture, Industry, Commerce and Communication where all-round improvement was maintained. Of special significance is the treatment of matters relating to Public Health and Education in this All-India review though they are primarily provincial subjects. A brief resumé of the work of the numerous scientific surveys is appended. The year was not without a bumper crop of both provincial and All-India conferences of economic and public interest.

Great credit is reflected on the authorities responsible for the production of this excellent report, which while preserving the high standards set up by its predecessors has achieved a notable advance inasmuch as it infuses a new spirit of approach even to the most common topics.

Forthcoming Events.

Central Board of Irrigation.

THE 6th Meeting of the Research Officers and the Executive Committee (Research Committee), Central Board of Irrigation, will be held on 7th-13th July 1936, to consider:

(1) To confirm the minutes of proceedings of the Fifth Meeting of the Research Committee, held at Simla on the 18th and 19th July 1935.

(2) To discuss the reports of the Research Officers on the research work done in their Provinces during the preceding year.

(3) To report progress in respect of the following subjects brought forward from last year:—(*a*) Means of conserving irrigation water. Stauching of canals. (*b*) Design of canal falls. Preparation of type designs. (*c*) Waterlogging and land reclamation. Questionnaire. (*d*) Testing and grading of silt. Standardisation of methods. (*e*) The Lacey silt and flow theories. (*f*) Tortuosity of rivers and their training by means of embankments. (*g*) Design of work on permeable foundations.

(4) To discuss the following new subject: Means to secure the equitable distribution of irrigation water in the future.

(5) To discuss the programme of research work to be carried out during the ensuing year, and

(6) To consider the question of Research Officers meeting during the cold weather.

Imperial Council of Agricultural Research.

July 8th and 9th, 1936.—Meeting of the Sugar Committee.

July 10th and 11th, 1936.—Meeting of the Wheat Committee.

July 13th to 18th, 1936.—Meeting of the Advisory Board.

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